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ELEMENTS

OF

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ECONOMICAL CHEMISTRY.

FOR

SCHOOLS AND FAMILIES.

By H. B. NORTON.

PART II. HOME, FARM, AND WORKSHOP.

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SAN FRANCISCO:
A. L. BANCROFT & CO., PRINTERS,
721 MARKET STREET,
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PREFACE.

THIS little book is the second part of a larger work which treats of Chemistry with especial reference to its applications in the workshop and the home. This small preliminary edition is printed, not for extended circulation, but principally in order to test it by a little actual class-room use, and also for the purpose of ascertaining the opinion of practical teachers upon the need and advisability of publishing the entire work, fully illustrated.

Part I, yet in manuscript, treats of the theoretical and experimental fields of chemical study, with especial reference to the needs of the student working without a teacher, and of the pupils in our public schools, who are compelled to study almost without apparatus. In preparing Part I, the aim has been to reduce the catalogue of needful apparatus to the smallest possible amount, and to make the explanations and illustrations so clear that the young student shall be able to master and explain the needful manipulations without danger or mistake, and at the smallest possible cost.

Part II, as has been said, treats more particularly of the economical and hygienic applications of the subject. It has grown out of many years of actual class-room work, in which Youmans' "Household Science" has been a favorite text-book. That admirable work has been for many years in the field without the publication of a revised edition; and during the past twenty-five years the growth of science, theoretical and practical, has been very great. It has been necessary for the author, year by year, to supplement the work by memoranda drawn from various sources, and representing this growth. Out of this added material, the present work has grown.

It is not pretended that the topics treated of, respectively, in Parts I and II, are separated by lines rigidly drawn. All such classifications must, at the best, be but approximate and incomplete.

The enormous evils which have resulted from the use of alcoholic and narcotic poisons, and from other habits prejudicial to our physical well being, have created a growing demand for a text-book which shall fully recognize these evils, and clearly explain their nature and origin. The chapters entitled "The Vegetable Alkaloids," "Alcoholic Beverages," "Respiration and Assimilation," and "The Toilet," contain lessons which were prepared in order to satisfy this demand.

Part II is also intended to be, in some measure, a book of reference for those who have not been able to enjoy the higher education, but to whom questions are forever being presented concerning the chemistry of common things.

The author, in closing, desires to acknowledge the assistance that has come from many sources. Youmans' "Household Science," Ellen H. Richards' admirable little work upon "The Chemistry of Cooking and Cleansing," "Johnston's Chemistry of Common Life;" and Prof. T. J. Burrill's remarkable little work upon Bacteria, have all been freely drawn upon. Thanks are also rendered to Dr. H. C. Morey for special favors.

State Normal School, San Jose, Cal., March 1, 1884.

TABLE OF CONTENTS.—PART II.

		PAGE.
I.	The Vegetable Alkaloids	7
II.	The Vegetable Acids	11
III.	Fats and Oils	12
IV.	Starch, Gum, Sugar, Wood	15
V.	The Albuminoids	20
VI.	The Ferments	21
VII.	Bread	26
VIII.	Alcoholic Beverages	29
IX.	Flesh-Meats and Other Animal Food	32
X.	Illuminating Agents	35
XI.	Respiration—Animal Heat—Vital Force	38
XII.	Cleansing	41
XIII.	Drinks	44
XIV.	The Toilet	47
XV.	Paints and Varnishes	51
XVI.	Dyes and Inks	52
XVII.	Houses and Furniture	54
XVIII.	Anæsthetics	57
XIX.	Poisons and Their Antidotes	58
XX.	Insecticides and Destroyers of Vermin	60
XXI.	Chemistry of Plant Growth	61
XXII.	Calcium, Mortar, Cement, Plaster	63
XXIII.	Rocks, Gems, and Ores	66
XXIV.	Explosives and Pyrotechny	69

ELEMENTS OF
ECONOMICAL CHEMISTRY.

I. THE VEGETABLE ALKALOIDS.

This term is applied to a series of true bases extracted from vegetable tissues. They contain C, H, O, and N, in varying proportions, and are often poisonous. The number of them is very great.

1.	NICOTINE.	$C_{10} H_{14} N_2$
2.	MORPHINE.	$C_{17} H_{19} O_3$ N.
3.	QUININE.	$C_{20} H_{24} O_2 N_2$
4.	THEINE.	$C_8 H_{10} O_2 N_4$
5.	CAFFEINE.	
6.	SALICINE.	
7.	STRYCHNINE.	$C_{21} H O_2 N_2$

NICOTINE is extracted from tobacco. It is a transparent, oily liquid, soluble in water, alcohol, and the fixed oils. The tobacco leaf contains from two to eight per cent. of this oil. It is a burning, acrid, exceedingly deadly poison. When tobacco is smoked, chewed, or snuffed, this oil is absorbed in small quantities, and is carried into the circulation. It is a narcotic, depressing and de-vitalizing. It unduly excites the salivary glands, causing a waste of their secretion. Saliva abounds in albumen secreted from the blood, and any excess in flow of it is debilitating. Tobacco also makes the breath foul, impairs the action of the brain, tends to paralysis, lip-cancer, indigestion, and all forms of nervous disease. Its effects upon the young are especially deplorable.

Dr. Gibbon, Medical Director, U. S. N. Academy, in retiring from the institution desired to leave it as his last utterance that, "beyond all other things, the future health and usefulness of the lads educated at this school require the absolute interdiction of tobacco."

He adds: "An agent, which, through its sedative effect on the circulation, creates a thirst for alcoholic stimulation; which, by its depressing and disturbing effect on the nerve centers, increases bad passions; which determines functional diseases of the heart; which impairs vision, blunts the memory, and interferes with mental effort and application; ought, in my opinion as a sanitary officer, at whatever cost of vigilance, to be rigorously interdicted."

Degeneration of the cardiac muscle is often caused by tobacco. So long as the rest of his organism remains in good working order, the smoker only experiences intermittent palpitation; and the grave injury done the heart remains unperceived until some trifling cause brings into relief the irremediable disorders produced by the prolonged use of tobacco.—Dr. Deschamps, in *Galignani.*

In 1880, the tobacco manufacturers of America paid excise-tax upon a product of about 472,000,000 pounds, or more than nine pounds for each man, woman, and child in the United States. The present annual crop of tobacco exceeds 500,000,000 pounds, and is rapidly increasing. The direct cost to consumers cannot be less than $400,000,000 annually. The evil caused by the uncleanliness of the drug, its tendency to increase alcoholic intoxication, and its destructive effect upon health and vitality, is beyond computation. Modern civilization has no worse enemy.

The pernicious work of tobacco is heightened by its various adulterations. Many brands of smoking tobacco contain a small amount of opium, which is added to increase the sedative effect. Cigarettes are often made of glazed paper containing arsenic, and filled with fine-cut cigar stumps and various refuse. The miscellaneous salivary contributions to this material must be viewed with grave suspicion as tending to spread the germs of lip-cancer, and other diseases. Nitre is constantly used to make cigars burn freely.

SNUFF is taken much less than formerly, though the habit still lingers. Its use destroys the sense of smell, injures the vocal chords, and creates a chronic catarrhal irritation. Deafness frequently follows its use.

MORPHINE is a crystalline solid extracted from opium, composed of long, silky fibers. Its name is derived from Morpheus, the god of sleep.

OPIUM is produced in India, China, and Persia. The poppy-plant is extensively cultivated, and, at a certain period of its growth, workmen pass along the rows and make slight incisions in the head or seed-vessel. A milky juice exudes, and dries into the brownish gum, opium.

In this crude state it is extensively smoked in China and the East Indies. Dissolved in alcohol, it forms laudanum. A more diluted tincture, flavored with camphor and spices, is called paregoric. The various "soothing syrups" and "cordials" owe all their efficacy to the presence of opium. They are all stupefying poisons, exceedingly destructive to the health of infants, for whom they are mainly prepared.

Morphine is the most important of six or more alkaloids extracted from opium. It is extensively used in medicine as a narcotic. It should never be administered except by the advice of a wise physician. It is given by the mouth, or injected under the skin, by means of a hypodermic syringe, in order to alleviate pain and produce sleep. Too often, however, the habit of using it continues after the immediate occasion has ceased. The habitual use of opium and its derivatives seems to be constantly extending in all parts of the world. At first the effect is pleasant, but the system requires steadily increasing doses of the drug, in order that this may continue. Soon it becomes practically impossible to break off the pernicious habit. The nervous system is speedily ruined, and a horrible death ends the story.

People often die from an overdose of morphine, given to deaden the pain of neuralgia, or some similar disease. An eighth to a sixteenth of a grain is the proper dose, or a mass of the powder as large as a grain of wheat. Only desperate cases warrant a non-professional person in using this drug. Its indiscriminate administration to infants is especially to be condemned. Many thousands die annually on account of the ignorance or indolence of mothers and nurses, who poison their babes with "soothing syrups" or "cordials."

QUININE is one of several alkaloids extracted from the bark of the cinchona tree, which is also known as Peruvian bark and Jesuits' bark. The crude bark is pulverized and digested in water, and the alkaloid dissolved out by the aid of sulphuric acid. Almost all of our cinchona bark comes from the slopes of the Andes.

Quinine is much used in medicines as a cure for intermittent fevers. It destroys the low organisms which probably cause malarial disease. In overdoses it causes nervous derangements, deafness, and other disordered conditions. *Cinchonine* is a similar alkaloid, but milder in its effects. *Chinoidine* is a gummy extract, chemically very complex, from the same source.

The discovery of cinchona, and its derivatives, has been a great blessing to humanity. It has made possible the opening up to settlement of many malarial regions where health cannot be preserved without these remedies.

TEA AND COFFEE contain the alkaloid known as Theine or Caffeine.

The Tea of commerce is procured from China, Japan, and Assam, a province of India. It is the leaf of a shrub of the order *Ternströmaceæ*. About 50,000,000 pounds of tea are annually imported into this country from various sources.

The terms Green and Black, as applied to tea, do not refer to distinct varieties of the plant, but rather to the method of preparing the leaf.

Green tea is gathered while the leaves are young, and is dried quickly; black tea includes the riper leaves, which are "sweated" and fermented.

The Green tea of commerce is almost universally painted and adulterated. Turmeric, indigo, Prussian blue, and plaster of Paris, are the agents most commonly employed in coloring green teas. Graphite, iron-filings, and other adulterants, are mixed with the black teas. Old spent leaves of tea are gathered at restaurants and prepared for the market. The leaves of other plants are gathered and mixed with the genuine product.

Experiment. Burn in a retort 100 grains of tea. If the tea be pure, not more than 5 or 6 grains of ashes will remain. In adulterated teas, the ash sometimes amounts to 45 per cent.

Japanese teas are less adulterated than those of China. The Chinese black teas, and the "uncolored Japan" are least likely to contain injurious mixtures;

Tea owes its value to three chemical principles:—Theine, aromatic oils, and tannic acid. Theine is said to diminish waste of tissue, thus taking the place of other food. The aromatic principle is exhilarating, and is either a nerve-food or nerve stimulant. The tannic acid is deleterious, and the least possible amount of it should be dissolved in the beverage. (For the proper preparation of tea as a beverage, see the chapter on Drinks.)

Pure tea, taken in moderate quantities, and properly prepared, is refreshing and stimulating. The adulterating agents, especially including Prussian blue, are poisonous. If the tea-infusion contains much tannic acid, it impairs the digestive power and injures the complexion. Good tea is generally a healthful and useful drink for adults, especially brain-workers.

Coffee is the seed of a tree belonging to the natural order *Cinchonaceæ*. It is grown in Arabia, the East Indies, Brazil, Central America, and the equatorial islands.

The fruit, which resembles a red cherry, is gathered and dried or fermented, in order that the pulp may be removed from the seeds, which lie with their flat sides together, two in the centre of each berry. The pulp is removed by pounding in water, and the seeds are selected, dried, and sacked for market.

The best coffee, called Mocha, comes from Arabia; the second quality is sent from Java; and the third from tropical America. If coffee is kept for a term of years in a dry place, a slow oxidation and ripening goes on, greatly improving its quality. American coffees are said to attain their perfection of quality after being ten or twelve years in store.

The important principles of coffee are included in the alkaloid Caffeine, an aromatic essential oil, and Caffeic Acid.

Caffeine, identical with Theine, has been discussed above. The essential oil is developed and volatilized in the process of roasting. The Caffeic Acid is supposed to be the principal flavoring agent. (For the preparation of coffee as a beverage, see the chapter on Drinks.)

Coffee is a fragrant and delicious drink, seemingly beneficial in its effects in equatorial regions, but often tending to biliousness, gastric acidity and "heart burn," when freely used by those living in colder climates.

The almost universal use of milk with tea and coffee has a scientific reason behind it. The caseine is coagulated by tannic acid entering into chemical union with it, and rendering the latter inert. Without milk, the coagulating power of the acid is expended upon the albumen of the stomach.

Chocolate is a decoction of the roasted seeds of the cacao-tree. The shell or envelope of the seed, roasted and ground, is called Cocoa. These substances contain Theo-bromine, an alkaloid identical with Theine; also, much fixed oil, and starch. Chocolate is palatable and nourishing, but to some persons difficult of digestion.

Strychnine is extracted from the East Indian tree *Strychnos Nux Vomica*. It forms solid, shining crystals, is intensely bitter, and is one of the most active of poisons, producing powerful convulsions and a speedy and most agonizing death. It is much used for the destruction of predatory animals, and is a favorite instrument of murder and suicide.

Remedies must be very prompt in order to be efficacious. 1st.—Evacuate the stomach with an emetic or stomach pump. 2d.—Administer large doses of olive-oil, lard, or any unctuous oil. This seems to unite with and neutralize any remaining portion of the poison. Sweet milk may be substituted. 3d.—If spasms begin, administer vapor of chloroform as often as they recur. This treatment with chloroform must sometimes continue twelve or eighteen hours.

A Test. The test for strychnine is as follows:—Evaporate upon a clean slip of glass a single drop of the suspected solution. Touch the spot with sulphuric acid, and then with a very small crystal of bichromate of potash. The presence of strychnine is indicated by a rapid play of changing colors: violet, purple, and light red.

In minute doses, strychnine is much used as a medical agent. Agues, nervous exhaustion, the prostration following drunkenness or delirium tremens, are all successfully treated with small doses of strychnine; 1-30 to 1-60 of a grain being generally administered at one time.

Brucine is another alkaloid obtained from the same plant as strychnine. *Salicine* is extracted from the bark of the willow, and is administered in the treatment of rheumatism.

Cannabis Indica, the Indian hemp, yields an extract somewhat similar to opium in its effects, but more powerful and maddening. This extract is called *Hasheesh* or *Bhang* in different countries of Asia. It powerfully excites the imagination, and produces a wild delirium. This drug sometimes takes the place of alcohol in spurious whisky.

Coca is a plant of the genus *Erythroxylon*, extensively grown in equatorial South America. It contains an alkaloid called *Cocaine*, which is probably its most important principle. The coca-leaf is chewed with a little lime by Indians bearing burdens over the Andes. It is said to deaden pain, to make respiration easier, and to take the place of food. This herb is now being medicinally tested in this country.

II. THE VEGETABLE ACIDS.

Oxalic Acid.	$C_2\,H_2\,O_4$
Citric Acid.	$C_6\,H_8\,O_7$
Tartaric Acid.	$C_4\,H_6\,O_6$
Malic Acid.	$C_4\,H_6\,O_5$
Tannic Acid.	$C_{27}\,H_{22}\,O_{17}$
Gallic Acid.	$C_7\,H_6\,O_5$
Salicylic Acid.	$C_6\,H_4\,OH\,CO_2\,H$
Prussic Acid, or Hydrocyanic Acid.—	$H\,C\,N$.

Oxalic Acid is obtained from the leaves of sorrel, rhubarb or pie-plant, yellow dock, and other vegetables. In its commercial form, it consists of large, solid, intensely sour crystals.

This acid, as it exists in the leaf of sorrel and the stem of rhubarb, is a harmless and agreeable article of food. In its concentrated state, it is an active and corrosive poison. Combined with tin or lead, it forms poisonous salts of peculiar virulence. Rhubarb-stalks should never be preserved for food by drying or canning in tinned vessels.

Oxalic acid is a powerful bleaching agent. It decomposes ordinary inks by uniting with the iron which they contain, and forming a soluble and colorless salt. In this way ink-stains may be removed from white goods.

Oxalic acid is extensively manufactured from sawdust, by chemical synthesis.

Citric Acid abounds in the citron, lemon, lime, orange, and some other fruits. It is much used as a medicine, on account of its power to cure biliousness and scurvy. Ship-masters are required by law to carry lime-juice for the use of the crew and passengers. Citric acid gives to lemonade its agreeable flavor and healthful qualities. It has bleaching properties similar to those of oxalic acid, but less powerful.

Tartaric Acid is obtained from the grape and other fruits. In the process of fermentation of grape juice, a white crust called "wine-stone" is precipitated at the bottom of the casks. This is "cream of tartar," or bitartrate of potash. From this compound tartaric acid is obtained.

This acid, combined with antimony and potash, forms *Tartar Emetic;* combined with soda and potash it forms *Rochelle Salts,* much used in medicine in the form of *Seidlitz Powders.*

Malic Acid is abundant in apples, especially the unripe fruit. Its uses in the arts and industries are few.

Tannic Acid abounds in the nut-gall, an excrescence formed on the leaves or twigs of the oak around the eggs and larvæ of gall-flies; also in the bark of the oak and hemlock, the tea-leaf, the coffee-berry, and many other vegetable tissues.

Tannic Acid unites with all the albuminoids, forming insoluble compounds. If taken into the human stomach it coagulates the albumen of the mucous membranes, greatly impairing their power to digest and absorb.

The skins of animals are soaked in a solution of tannin obtained by steeping oak or hemlock bark in water. The soluble gelatine of the raw hide is thus changed into the thick, firm, water-proof tissue of leather.

Tannin from nut-galls readily combines with the iron in copperas or ferric sulphate, forming a black tannate of iron, or ink.

Gallic Acid is everywhere found associated with the tannic, and has similar properties. The two seem so related that the gallic acid can be made from the tannic.

Salicylic Acid is found in the bark of the willow, but is generally formed by synthesis from the elements of carbolic acid, acted upon by carbon dioxide. It is a powerful and most valuable antiseptic, destroying a great variety of low organisms. It is much used in medicine, in the treatment of diseases caused by ferments. It dissolves slightly in cold water, but freely in hot water and alcohol. It combines with soda and other bases, forming soluble salts. A spoonful of the salicylate of soda solution or of the acid dissolved in alcohol, poured upon the surface of a bottle of jelly or preserved fruits, will completely prevent the formation of the blue mold so annoying to housekeepers.

Prussic Acid is obtained from the bitter almond, and abounds in the seeds of the peach, plum, and other fruits. The delicious flavor of the peach is largely owing to the presence of prussic acid, greatly diluted. In its concentrated form, this acid is one of the deadliest of poisons. A single drop, placed upon the human tongue, will usually produce instantaneous death. This is caused, probably, not by absorption, but by a destructive shock or impression, propagated along the nerves. Children are occasionally killed by excessive eating of the seeds of plums and peaches. For the concentrated poison there is no known remedy—its action is too instantaneous.

III. FATS AND OILS.

Fats and oils form a series commonly divided into two great groups called Essential and Fixed Oils.

Essential oils may be vaporized by heat, and condensed again into a liquid or solid form, without changing their chemical composition. Fixed oils cannot be vaporized.

The essential oils are nearly pure hydro-carbons. They are sometimes divided into three groups. The first group includes benzine, turpentine, and similar compounds. Turpentine is obtained from the pine tree. When purified by distillation, it is called *spirits of turpentine* or *camphene.* Its composition is $C_{10} H_{16}$. Oils of lemon and orange are of this class.

Turpentine, when exposed to the air, slowly oxidizes, and forms *rosin.* It is probable that two atoms of H are withdrawn from it, uniting with one of O, and forming water.

Turpentine freely dissolves the fixed oils. The pure *spirit* of turpentine is valuable to remove grease from garments.

Varnishes. Turpentine has the power to dissolve various resins, forming the sticky translucent compounds called *varnishes.* These *dry*, or harden, through the evaporation and oxidation of the turpentine.

THE SECOND CLASS of essential oils includes the fragrant principles of various plants and flowers. The oils of rose, wintergreen, peppermint, bitter almonds, and camphor, belong to this class. These are all isomeric with turpentine, having the formula $C_{10} H_{16}$. They dissolve freely in alcohol, forming *essences.* Camphor is a remarkable member of this group. It is obtained by distillation from the leaves and boughs of the camphor-tree. It freely vaporizes when heated, and is much used in medicine as a semi-narcotic and antiseptic. In large doses it is poisonous.

THE THIRD CLASS of essential oils includes various rank and strongly odorous substances, such as the oils of the onion, horse-radish, mustard, cress, and some others. These substances contain C, H, N, and often S.

Plants containing these oils are counted valuable as having antiseptic properties. Arctic travelers constantly employ them as remedies for the scurvy. Our natural relish for mustard, radishes, cresses, and similar vegetables, seems to indicate that they often supply a need in the economy of the human system.

Perfumes. Oils of lavender, the various mints, cinnamon, and similar compounds, are obtained by heating in close retorts, and distilling over water. The oil, when cooled, is found floating upon the surface of the water. It is dissolved in alcohol, forming *essences.* They might be formed by digesting the leaves of the plants directly in the alcohol, but would be less pure, as a variety of other substances would also be dissolved.

The very delicate perfumes of the rose, violet, and similar flowers, are obtained by placing the petals between sheets of white paper, covered with fresh butter. The oil is absorbed by the butter, which is afterwards digested in alcohol, and the solution is filtered.

Oils of lemon and orange are obtained by direct solution from the rinds of the fruit, which are soaked in alcohol, to form extracts or essences.

The various handkerchief perfumes, such as "Jockey Club," "Night-blooming Cereus," and others, are made by mixing these essences in various groupings and proportions.

THE BALSAMS AND RESINS. These are formed, as we have seen, by the slow oxidation of the essential oils.

ROSIN is the residuum that remains after the distillation of turpentine.

TAR is a mixture of turpentine and lamp-black. It is obtained by the partial combustion of pitch-pine logs, which, after being kindled, are covered with earth, and burn slowly. The tar, thus formed, flows down into a trench at the bottom of the pile of wood, and is dipped into barrels. *Pitch* is formed from tar by the evaporation and oxidation of the turpentine.

FIXED OILS. These substances may be sub-divided into Unctuous and Drying Oils.

The Unctuous Oils include all animal oils, and such vegetable products as palm oil, olive oil, and cotton-seed oil.

The Drying Oils absorb oxygen from the air, and harden, forming a firm, varnish-like mass. Linseed oil, extracted from flax-seed, is the principal example.

An Unctuous oil has essentially the nature of a salt, in which the base is glycerine ($C_3 H_8 O_3$) combined with stearic, margaric, and oleic acids, in case of animal fats, and with palmitic acid in palm oil.

These acids, combined with soda or potash, form soap.

Glycerine is a very sweet substance, syrupy in consistence, freely dissolving in water. It is used in medicine, and in the manufacture of various toilet articles. Combined with nitric and sulphuric acids, it forms a very complex and fearfully explosive salt, called *nitro-glycerine.* This substance has a sweet, pungent taste, and is sometimes administered as a medicine.

Stearic Acid is a firm, translucent, white substance, much used in the manufacture of candles. *Spermaceti* is a similar substance, obtained from the head of the sperm whale. *Paraffine* is the firm, white fat-acid of coal-tar. Beeswax is an exudation from the skin of the honey-bees. These insects scrape it off as it exudes, and build it into the structure of their cells.

These various fat-acids, united with soda or potash, form soap.

Soft-soap is made by packing wood-ashes into a suitable box or barrel, pounding them down firmly, and then pouring on water, which gradually leaches through the mass, dissolving the potash and forming *lye.* This is boiled with any sort of grease, forming a very active and caustic soft-soap.

In making hard soap, soda is used in place of potash. It has less affinity for water than potash has, and remains dry and firm.

Palm Soap is made of oil extracted from the palm-nut.

Castile Soap is made of soda and olive oil. It is often colored a clouded red by adding earth containing oxides of iron.

Oils and fats are extensively used as food. They seem to furnish, in Arctic regions, the only means of maintaining bodily warmth. Hence people living in high latitudes consume great quantities of fat. In temperate regions butter is much used for the same purpose. The people of southern Europe use olive-oil as an economical and healthful substitute, and in equatorial regions various vegetable oils are largely consumed. The nuts of different sorts of palms furnish the most of this.

In the Southern States of America, cotton-seed oil takes the place of olive-oil for many purposes. It is perfectly healthful and pleasant to taste when fresh.

Linseed oil, owing to its "drying" qualities, is the principal agent used in mixing paints. *Putty* is a mixture of linseed oil and fine chalk; *printers' ink*, of this oil and lamp-black.

Castor oil is obtained from the seeds of the castor bean. It is used in medicine, and for lubricating machinery.

IV. STARCH, GUM, SUGAR, WOOD.

Chemical Composition:—

Compounds

STARCH	$C_6 H_{10} O_5$
GUM OR DEXTRINE	$C_{12} H_{22} O_{11}$
CANE SUGAR	$C_{12} H_{22} O_{11}$
MILK SUGAR	$C_{12} H_{22} O_{11} + H_2O$
GRAPE SUGAR	$C_6 H_{12} O_6$
WOOD CELLS OR LIGNIN	$C_{18} H_{30} O_{15}$

vegetable fibre

The substances named above are, at the final analysis, substantially identical in composition. The atoms of one molecule of water, added to or subtracted from the formula for any one of them, will cause its elements to assume proportions essentially identical with those of any other one.

Such substances are said to be *isomeric*. Their elements, identical in kind and in proportion, are supposed to be differently grouped in the molecule, thus giving rise to the various properties manifested by these substances. They are, to a considerable extent, convertible into each other by chemical manipulations. Thus starch, or woody fibre, may be turned into gum or glucose. In the economy of plant life, this convertibility is very strikingly exhibited. (See Chap. 30.)

These substances are not true or complete foods in the sense of containing all the elements of nutrition,—nitrogen is wanting. They are probably used as nourishers of fatty tissues, and hence as fuel; and there is much reason to suppose that their elements may be dissociated in the process of digestion and assimilation, and used to build up the other tissues of the body.

STARCH is found in many plants in grains varying in size and form, and usually symmetrical in structure. They are often arranged in concentric layers. Starch is insoluble in cold water, but when heated to 140° F., the starch-grains burst, and the mass becomes gelatinous. In this form it is used in the laundry to make linen fabrics stiff and glossy.

DEXTRINE OR BRITISH GUM is made by heating starch under pressure to a temperature of 400° Fahr. It is changed to a clear, brittle solid, soluble in cold water.

GUM ARABIC is a similar substance which exudes from the bark of a sort of acacia. Mucilage, much used as an adhesive agent, is a similar substance, mechanically combined with water.

GUM TRAGACANTH is obtained from a variety of acacia called *Astragalus*. This gum is exceedingly strong and adhesive.

TAPIOCA is a sort of starch obtained from the root of a plant called *Manioc* or *Manihot*, much grown in equatorial regions. It forms a large portion of the food of the Indians of the Amazon. The roots are cleansed and then grated to a pulp. This pulp contains a milky, poisonous juice, which is extracted by pressure and washing. The large granules of tapioca starch remain.

TARO (tah-ro) is a starch manufactured from the root of the *Caladium Esculentum*, a plant greatly grown in the Sandwich Islands. The pulp of it is fermented, forming a substance known as *poi*, and extensively used as food. The name Taro is applied by the Sandwich Islanders to the plant and to its product.

Sago is a similar material, manufactured from the pith of a certain African palm. These forms of starch, so much consumed as food in the equatorial regions, do not tend to promote mental vigor or bodily energy. The people so using them become excessively corpulent, and are indolent and listless, and feeble in vitality.

Caoutchouc (ko-chook) or gum rubber, mostly comes to us from the Amazon basin. It is the milky juice of a tree often seen in our conservatories. The Indians make incisions in the bark of this tree, and fasten beneath these the empty shells of the cocoa-nut. The juice oozes into these cups, and undergoes a process of drying and oxidation which converts it into the elastic gum of commerce. It is blackened by smoke, and hardened, or *vulcanized*, according to Goodyear's patent, by heating it with sulphur. The two combine, forming the "hard-rubber" of commerce. It is colored with vermilion, a sulphide of mercury, to form dentists' plates.

Gutta-percha is a similar gum, obtained in Borneo and Malacca. It may be vulcanized like caoutchouc.

Cane Sugar is made from the sugar-cane, and in small quantities from the stalk of sorghum and maize. It is also made extensively from the beet-root, maple tree, and the juice of certain species of the palm-tree.

The equatorial sugar-cane forms no seed. It is propagated by planting cuttings or layers, and fills its growing stem with sugar as material with which to nourish the sprouts which bud from its joints when it is buried in the earth. Louisiana, Cuba, Guiana, the Sandwich Islands, and Mexico, furnish this country with most of its raw sugar.

The cane-stalk grows to a height of several feet, then often falls to a horizontal posture and grows upward again, so that the mature stalk is greatly bent. The upper part of it contains very little sugar. It is cut off, and the leaves are trimmed away, after which the stalk is crushed between heavy iron rollers. The juice flows out in a greenish stream into the vats where it is to be clarified. It contains much gluten, and also a portion of organic acid. Lime is added to neutralize the acid and to coagulate the gluten, which falls to the bottom. The clear juice is now boiled down to *raw* sugar. In this condition it is of a brownish tint, each crystal being coated with molasses, which is a mixture of water, gluten, sugar, and various impurities.

The raw sugar is dried and whitened by being placed in a drum with a vertical axis, whose sides are of perforated metal. This drum is rotated with great rapidity, and the centrifugal force generated by this rotation causes the molasses to fly in streams, in all directions. The sugar, thus freed from a large portion of its impurities, is now sent to the refineries. Here it is dissolved and filtered through a bed of bone-black several feet in depth. The clarified juice is again boiled down, and crystallizes into refined white sugar.

Inferior grades of raw sugar are often bleached with the aid of the chloride of tin. This sugar has a bluish tint, and is counted rather unwholesome.

The molasses described above is not over-clean, but is much used in the making of rum, and in certain articles of cookery.

Golden Syrup is a solution of the higher grades of sugar.

Beet Sugar is now manufactured in Europe and America to an extent of some 300,000,000 lbs. annually. The beets are of several varieties, but one of a pale pink tint is the favorite. The beets are washed, ground to a pulp, and subjected to a heavy pressure to extract the juice. This is filtered, treated with lime and other agents, and boiled down like cane-juice. The beet-juice contains a greater variety of impurities than the cane-juice does, and the chemical treatment is more complicated. A white, fine-grained sugar is produced from the beet, the average yield being perhaps one-and-a-half tons to each acre of land. A hundred pounds of beets will yield six to seven pounds of sugar. The pulp, after pressing, is fed to cows and other domestic animals. The molasses is nearly worthless.

The sugar-cane yields a much larger percentage of sugar than the beet. It is said to give from two to ten tons of raw sugar per acre, according to locality and the variety of cane planted.

THE SORGHUM CANE is much cultivated in the Northern States. It bears seed, and yields a considerable percentage of cane-sugar, very much mingled, however, with acid, glucose, and gum. It makes a very palatable syrup when properly treated. The stalks are trimmed and pressed, the juice treated with lime-water, skimmed, and finally boiled down to syrup. It may be clarified, like cane-sugar, by filtering through bone-black.

MAPLE SUGAR is made by boiling down the juice of the sugar maple, (*Acer Saccharinum*) a tree which grows abundantly in Canada and the Northern States. The roots of this tree, during the winter, store up a quantity of sugar to be converted into cells, and used for the purpose of forming new leaves in the spring. This sugar is produced by the action of an acid upon the starch and lignin of the root.

In the spring the sweet sap flows upward through the white or sap-wood of the tree. This flow usually occurs in February and March, while the snow is thawing. At this time holes are bored into the sap-wood, and tubes of wood or metal are driven in. Through these the juice flows out into buckets, whence it is emptied into casks, hauled to the "sugar-camp" and boiled down. It forms hard cakes, having a peculiar and pleasant taste. The juice is not nearly so sweet as that of the beet or sugar-cane, and large quantities of fuel are consumed in evaporating it.

After the leaves of the maple begin to form, the sap that flows out lacks sweetness ; it is gummy, and makes a dark, unpalatable syrup.

It is said that the annual average of production of maple sugar steadily diminishes. The process is very destructive to the trees, and new ones are seldom planted.

JAGGERY or palm sugar, is made from the juice of the date palm. It is seldom refined, but is consumed in its raw state. Some 10,000 tons are annually produced in the East Indies.

PINE SUGAR is made to some extent by the Indians of the Pacific slope, from the sap of the sugar pine. This magnificent tree yields a considerable quantity of a fine-grained, light-colored sugar, which often has, however, a decidedly resinous taste, and hence is not manufactured to any great extent.

CARAMEL is formed by heating cane sugar to a temperature of 420° Fahr. It is dark-colored, has a bitter taste, and is not crystallizable. It is much used as a coloring agent in candies and liquors.

MILK SUGAR, or LACTOSE, is manufactured from the whey of sweet milk. It forms hard, transparent crystals, soluble with difficulty. It is much used as an agent or vehicle for the administration of medicines. Homœopathic pellets are made of it.

GRAPE SUGAR, or GLUCOSE, exists abundantly in a great variety of fruits. It may be seen in candied masses upon the skin of the fig and raisin. It may be artificially made from starch, gum, cotton, linen, or woody fiber.

In the Mississippi valley, large quantities of glucose are manufactured from corn-starch. This substance is boiled for several hours in a solution of sulphuric acid. The acid is then removed by adding lime; calcic sulphate, or gypsum, is formed, and as it is almost insoluble it settles to the bottom of the tank. A clear, sweet, syrupy liquid remains. It may be used as food in that form, or may be evaporated into the solid crystalline form.

Glucose is extensively used in sweetening wine, and in the manufacture of candy. The "pulverized sugar" used in icing cakes is made of it, and cane sugars are much adulterated with it. It has not over half the sweetening power of cane sugar, and hence is not economical to use for general purposes.

Glucose is not unwholesome if properly made. The critical point in manufacturing it is to determine the exact amount of lime necessary to remove the acid. When this is carefully done, a slight trace of calcic sulphate remains in solution, but this is practically inert.

HONEY is made in the tubes or nectaries of almost all flowers. It is doubtful whether it is of any direct use to the plant; but indirectly it is of immense benefit. It is well-known that it is necessary or beneficial for flowers to be fertilized by pollen brought from other plants. This "cross-fertilization" is effected by the visits of bees searching for honey. Flying from flower to flower, this insect carries the pollen-dust from one to another, thus insuring "cross-fertilization." The honey-secretion is Nature's bribe to the bee, to thus assist in perfecting the seeds.

The best honey is made from white clover, and from the white sage of the Californian mountains. In certain regions of that state, there are many "bee-ranches" in exceedingly barren places, each having several hundred hives. The annual yield per hive often exceeds 100 pounds of the finest honey.

Honey contains much glucose, and a large variety of substances derived from various sources. The bee is eclectic. Cane-sugar, the "honey-dew" excreted by a plant-louse or aphis, and a variety of acrid or poisonous principles, are often stored up in the honey-comb, making it impossible for some persons to enjoy this luxury. The white sage honey is most free from these admixtures.

It seems certain that honey in the comb is not quite identical with that in the flower. The bee has added to it a portion of her own bodily secretions, especially flavoring it with Formic Acid.

MANNA is a sort of gum mingled with glucose and a peculiar variety of crystallizable sugar. It is mostly obtained from certain species of the ash, growing in Sicily.

SUGAR CANDY is largely made from grape sugar, mingled with a percentage of granulated cane-sugar, and various flavors, dyes, and adulterants.

TERRA ALBA, a sort of white earth, is much used as an adulterating agent, on account of its cheapness. Candy is colored with various pigments, often poisonous. The following are among the most important:—

Red	Cochineal. Beet-juice. Vermilion.
Green	Chrome Green. Paris Green.
Blue	Smalt (Glass of Cobalt). Carbonate of Copper.
Yellow	Chromate of Lead (Chrome Yellow). Gamboge.

To the immense and growing consumption of these unwholesome candies must be attributed much of the ill-health of American children. Acidity of the stomach, indigestion, premature decay of the teeth, and many other diseased conditions, naturally follow the use of these poisoned sweets.

Lignin, or woody fiber, is the principal material of wood, cotton, linen, and paper. It is formed in the plant by transformation from sugar, starch, and gum. It abounds in straw, the stalks of all herbs, and the envelopes of all seeds. It consists of numerous cells, usually arranged in fibers. In the outer, or *sap-wood* of trees, these cells are delicate, destructible, and filled with sap, but in the heart of our exogenous trees, the cells are empty of sap, dead, and partially incrusted with various mineral substances. Hence heart-wood is far more durable than sap-wood.

In some varieties of trees, like the teak of India and the Californian red-wood, the amount of mineral matter in the heart-wood is so great that the wood sinks in water. Such timber resists decay for a surprising period of time.

Paper.—This material is made by reducing to a pulp a great variety of ligneous fibers, and afterward moulding the material into thin sheets, which are smoothed by pressure, and often enameled with a "sizing" of gum or glue.

Our fine, white letter paper is made as follows:—Cotton rags are washed, bleached with chlorine-water, cut into small bits, boiled to a pulp, then strained, so as to remove all thread and fibers. The pulp is now made to flow in a thin stream upon the surface of an endless band of wire-gauze, which slowly rotates. A small roller prints it with some sort of fancy pattern, or stamps it with the "water-mark." At the end of this part of its journey, the layer of pulp, still moist and tender, is lifted from the endless band by rollers, some of them hot, which smooth and dry it. It now passes on and dips into the vat of gluey sizing. Beyond this, other rollers dry and press it. It is finally marked in lines by a system of pens moistened with blue ink, which move together in a sliding rack. Lastly it is cut into sheets, which are counted into bundles for use.

Coarse qualities of paper, for wrappers and similar uses, are made of straw and a variety of vegetable fibers.

Silk Paper, so-called, is a firm, delicate, linen paper.

Linen is the fiber of the flax-plant. The mature stems are cut and "rotted;"—soaked in water till the softer pulp decays. The fibers are then separated from the decayed mass by a process of combing. It is afterwards bleached by exposure to air and sunshine while moist, or by soaking in chlorine-water. Linen is one of the strongest of all fibers. A fine writing-paper is made from it.

HEMP is the fiber of the tall stalk of a plant called *cannabis sativa.* It is prepared very much like flax. It is a coarser and darker fabric than linen.

RAMIE is the fiber of a sort of perennial grass. It is strong, fine, and silky in luster. It is much used for adulterating silk.

COTTON is the fiber of the seed of a plant closely related to our common hollyhock.

CORK is the thick, spongy bark of the *Quercus Suber*, or cork oak, a tree growing in Spain.

PAPIER MACHE is a material formed of paper-pulp colored with various pigments, and pressed into moulds. It is often exceedingly hard and brilliant.

CELLULOID is made of paper-pulp mixed with gum-camphor, and subjected to enormous pressure. When colored red with vermilion, it is used for dental plates, artificial coral, and many ornamental purposes.

V. THE ALBUMINOIDS.

There is a class of bodies known as Albuminoids, or Proteids. The term Protoplasm is applied to these substances when they are considered as the materials out of which tissues and organs are wrought.

These substances, without exception, are formed in the cells of animals and plants. They are the most important of organic products, inasmuch as all the higher forms of animal life can only be maintained by the use of the Albuminoids as food.

COMPOSITION.—These bodies contain C, H, O, N, and often S and P, in varying proportions.

ALBUMEN is the "white" of eggs. It also exists in the eye and brain of animals. It is readily coagulated by heat and by the action of alcohol. The white of egg hardens at a temperature of 140° Fahr. It is also coagulated by contact with the salts of lead, arsenic, silver and copper, and by various acids. Hence arises its great value as a remedy for mineral poisons.

FIBRINE is found in the blood, in a soluble form. On exposure to the air blood forms into clots. These masses are red, because they contain vast numbers of the red blood-disks. These may be washed away, leaving the fibrine as a white, jelly-like mass.

Fibrine also exists in muscle-fibres, but in an insoluble form.

CASEIN is the curd of milk. It is coagulated by various acids, and by the bacteria or ferment-cells of the atmosphere. (See Chap. VI.) A substance substantially identical with the casein of milk is found in peas. Cheese is casein separated from the liquid portion of milk, salted, and pressed into cakes.

GELATINE is found in bone and cartilage. It abounds in the principal joints of animals. A sort of gelatine, very abundant in the membranes and air-bladders of fish, is called **ISINGLASS**.

An impure gelatine, extracted from the skins and joints of animals, is called **GLUE**. **SIZE** is a transparent gelatine, obtained from the skins of various animals. It gives the fine glaze to writing paper.

Gelatine has a chemical composition very similar to that of albumen, but it is nearly worthless as food. However, a large proportion of the so-called fruit-jellies consist of gelatine, variously colored and flavored.

GLUTEN is the nitrogenous principle of wheat and other grains. When wheat flour is washed for a while with water, the starch is removed, and nearly pure gluten remains.

The molecules of the proteids are very complex, and are peculiarly subject to oxidation, fermentation and putrefaction.

VI. THE FERMENTS.

The microscope has revealed the existence of a vast series of exceedingly minute organized bodies, which play a very important part in organic chemistry. It was formerly supposed that oxygen was the agent directly responsible in the phenomena of fermentation and decay; that the destructive process was communicated from one molecule to another, as a new form of motion. It is now known that all fermentation and putrefaction, and very many forms of disease, are caused by the presence and action of wonderfully minute living bodies. These are doubtfully classed as animal ~~or vegeta~~ble, animal but it seems exceedingly difficult to draw here the line which separates the great kingdoms of nature.

STRUCTURE.—Ferments are cells having walls of delicate membrane, filled within by a liquid protoplasm. They are reproduced by budding, by division, and by the development of minuter cells, called *spores*, which gradually enlarge to the size of the parent cell.

The variety of these organisms is very great. They are highly *polymorphic* or changeable in form; in different stages of growth, and under various surrounding conditions, organisms of a given species are so different in appearance as to be sometimes considered separate species.

ORIGIN.—The ferments, like all other living structures, are never spontaneously generated from dead matter; although it may sometimes be difficult to account for their presence, they are always derived from parent germs, floating in the air or lurking somewhere. All life is developed from pre-existing life.

A few of these organisms have been so far studied as to be named and classified. The following are among those best known:

TORULA CEREVISIÆ, the true yeast fungus, consists of spheroidal cells, about $\frac{1}{2500}$ of an inch in diameter. These are reproduced by budding; new cells growing from the old. Yeast is introduced into the wort of beer and the dough of bread, in order to produce the chemical effects of fermentation. It turns starch into gum and glucose, secretes or developes alcohol, and sets free carbonic acid, which produces the froth observable in yeast and beer.

SACCHAROMYCES REESII is the ferment found upon the skins of grapes. It floats in the air, and is often seen by microscopic aid, adhering to the surfaces of fruits. If ripe grapes or other fruits be crushed, the ferment is immersed in the sweet juice, and rapidly developes, causing the vinous fermentation and the evolution of CO_2.

MYCODERMA ACETI is a low fungus which causes the formation of acetic acid, or vinegar. It is commonly called the *mother* of vinegar. It is probable that other organisms, very small, but rapid in reproduction, also cause the formation of vinegar. These smaller organisms are grouped under the general name of *Bacteria*. They may be seen only through the aid of the most powerful microscopes.

BACTERIA are reproduced in a different fashion from that of the yeast fungus. In certain species, each individual begins as a single cell or spore, which grows by absorbing and assimilating the liquid in which it floats. It speedily forms a cross partition, and the single cell is changed into a double one. By a continuation of this process, the several forms which appear in figures 15 and 16 of the accompanying plate are developed. During certain stages of its growth, the organism moves with great rapidity, in the manner of an eel or a serpent. It is now called a *vibrio*. At last, when full grown, it often changes into a comparatively quiet and rigid chain of perfected cells, called a *bacillus*. It finally breaks up into a series of separate spherules, which are scattered through the liquid containing them, and each one of which resumes a round of development, similar to that described above.

The term *vibrio* is also applied to a single cell, having at one end a vibrating thread called a *cilium*. An organism spiral in form, having such a cilium at each end, is called a *spirillum*. (See Figs. 19, 20 and 21 of the plate.)

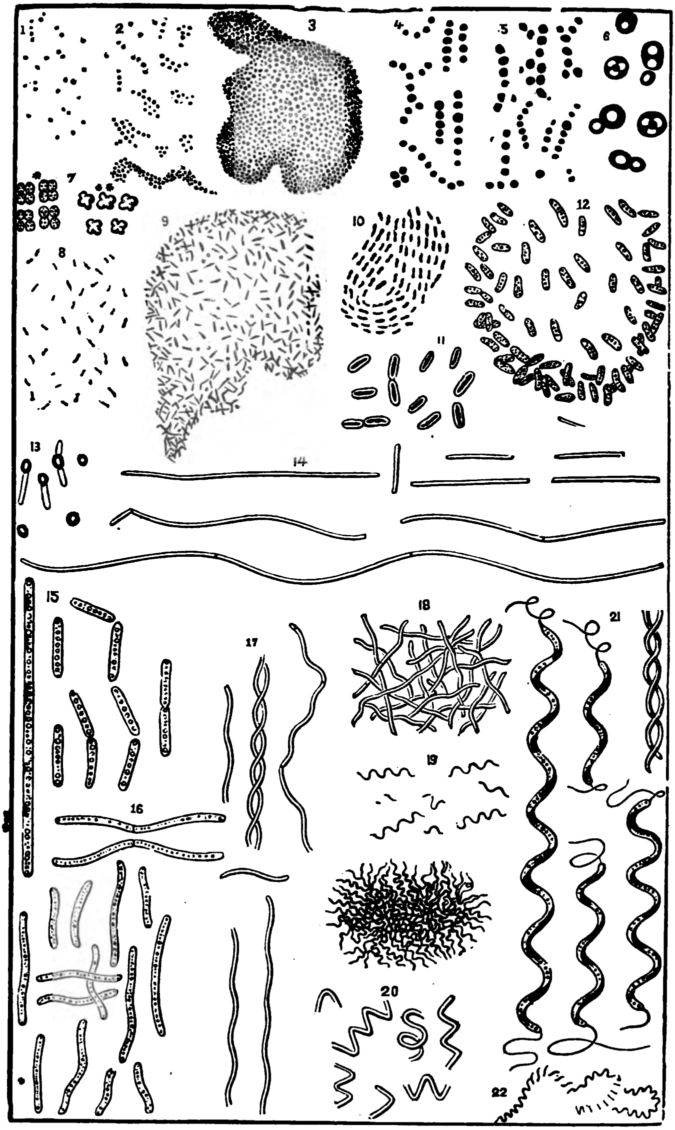
Certain spheroidal masses of bacteria cells are called *Zoogloea* (Fig. 3) and the presence of these seems to be exceedingly destructive to all living tissues. It can no longer be questioned that a great number of the diseases that scourge humanity, and especially those called epidemic and malarial, are caused by the action of various forms of bacteria. Tyndall and Pasteur suppose that each disease is caused by a specific germ, peculiar to itself. Cholera, Consumption, Typhoid and Malarial fevers, Diphtheria, Small Pox, and many other maladies may be included in this class.

It is also sufficiently proved that all putrefaction of organic matter is caused by these germs. Oxygen, thoroughly filtered, has no power to produce decay. It seems to be demonstrated by Tyndall's experiments that the cells of flesh must be broken through by bacteria before putrefaction can begin.

OXYGEN AND BACTERIA.—When oxygen consumes tissues, without assistance of bacteria, no evil odors, but only the gases of combustion, are developed. Bad breath, the fetid smell of disease, all the odors of putrescence, indicate the presence of these organisms.

BLOOD POISONING.—It is well known that a very small particle of putrid animal matter, introduced into the circulation of the living human body, will soon produce the terrible and rapid decay called *septicæmia*, or blood poisoning. This is certainly caused by germs somewhat similar to those described above. These divide and multiply with amazing rapidity, and one cell increases to many millions in the course of a few hours. The tissues of the body are everywhere perforated and destroyed, the living blood disks broken up, and the whole structure ruined and rotted with frightful rapidity.

There are organisms similar to those described, but which have a shorter round of development, each cell continually expanding and dividing into two, but not extending into a *bacillus*. Such a cell is called a *micrococcus*, (Figs. 1 and 2) and seems to be the cause of many maladies infecting the human system. It seems safe to assert that all fermentation, putrefaction and decay of organic matter, and all contagious, infectious,



BACTERIA.

[From the *Microscopical Journal.*]

and epidemic diseases, are caused by living germs. Quinine, chlorine, carbolic or phenic acid, and similar agents, are useful in medicine, mainly because of their power to destroy these germs. The drying, canning and preserving of fruits, the salting and smoking of meats, and the disinfection of cesspools and sewers, have really but one use—the destruction of the germs of fermentation and decay.

ANTISEPTICS.—Chemical agents having power to destroy such germs are called *Antiseptics.*

STENCHES AND MIASMS.—There are certain gases which indicate the presence and activity of the germs of putrefaction. Sulphureted Hydrogen (H_2S) and Phosphureted Hydrogen (H_3P) are the best known of these foul odors, but there are probably others, not well known or classified. The two gases named are both poisonous, but are not so dangerous as the germs of disease whose presence they indicate. In general, we are not made ill by the stench, but by the minute organisms which develop it.

Among these organisms one of the most dangerous is a minute *Micrococcus* bred in heaps of decaying vegetation, foul cellars, sinks and drains, which seems to be the active agent causing typhus and typhoid fevers. A similar growth is probably the active agent producing cholera.

H. W. Beecher says: "Cholera is God's opinion about nastiness!"

Perfect purity in our homes and surroundings is essential to bodily activity and health; but this is not always obtainable, especially in crowded cities, where one foul spot may poison the air for a great distance. Hence it is necessary to know how to resist these invading germs.

DRAINAGE PIPES.—In many of our pleasantest homes, we have made an elaborate provision for introducing these poisons directly into our sleeping apartments, through the drainage pipes of standing wash bowls. It has been discovered that a bend in the pipe, always full of water, is not a satisfactory safe-guard, as the sewer gases and poisonous germs are absorbed by the water on one side, and given out again upon the other.

All such drainage-pipes should be ventilated by smaller pipes reaching from *below* the bend to the chimney flue. Thus the foul and germ-laden vapors pass from the sewer to the open air.

DISINFECTANTS.—A sack of powdered charcoal, kept in the wash basin when it is not in use, is an admirable absorbent. It seems to condense and oxidize the gases and germs of putrescence.

Sulphurous Acid is a most valuable agent. Burn a little sulphur in the foul air of an unventilated cellar, and its condition improves at once. A house containing patients ill with consumption or scarlet fever, should be often fumigated in this way. The odor of the burning sulphur does not long persist, and it sweetens the air wonderfully.

Carbolic Acid is a most important agent, to be used in a similar way. If poured into a foul sink or drain, or scattered about an ill-smelling room, the effect is excellent.

A French chemist states that our ordinary commercial carbolic acid really contains two distinct principles:—the Phenic acid, which is colorless, and the Cresylic, which is of a pinkish tint. He injects the former under the skin of consumptive patients, asserting that thus the disease may be, and often is, cured.

SULPHATE OF IRON or Copperas, is a very cheap and powerful deodorizer and disinfectant. This is due to the fact that each molecule of it in the presence of the gases of putrefaction, yields up one equivalent of oxygen, and is thus transformed into a sulphide. The oxygen seems to destroy bacteria, and decomposes the foul-smelling gases.

CHLORINE, in its various combinations, is perhaps the most important of all. Chloride of lime is a very cheap and convenient form in which to purchase it. *Labarraque's Solution of Chlorine and Soda*, $Na\,O\,Cl$, is also an entirely satisfactory preparation.

ROASTING COFFEE exhales a powerful fragrance, which destroys evil odors. It has been asserted that this, and the odors of aromatic herbs and spices, change the oxygen of the air to the more active form of ozone, which destroys foul smells and germs of decay. This theory is not proved to be true, but certainly, fragrant herbs, gums and spices, have great antiseptic power.

ARSENIOUS ACID and MERCURIC CHLORIDE are most powerful antiseptics, useful for preserving human bodies or the skins of animals, but actively poisonous if taken into the living human system.

FOOD PRESERVERS.—Salt, borax, sugar, pepper, and carbolic acid, are greatly employed as preservers of food.

Salted and smoked meats owe their preservation to two causes: 1st, the drying, caused by the tendency of salt to absorb water, and of artificial heat to vaporize it; and 2d, the antiseptic effects both of salt and the carbolic acid of smoke.

Borax has remarkable power to destroy germs. Syrups of sugar are not truly antiseptic, but being dense and non-nitrogenous, they refuse to nourish the germs. Black pepper is a cheap and efficient preserver of fresh meats.

CANNING AND PRESERVING.—In canning fruits and meats, they are first heated to destroy germs, and then, while still hot, are sealed up in air-tight cans or jars.

Peaches, pears, apricots, and other fruits, are first peeled and halved, then promptly placed in cans; they are covered with hot syrup, and heated to a temperature of 212° or upwards. This effectually destroys bacteria. A tin cap is soldered to the can before the heating begins. It is punctured with an awl to allow the steam to escape, but the aperture is closed with a drop of solder when the can is removed to a cool place. Prepared in this way, canned fruits may be preserved almost indefinitely.

Green corn is more difficult to preserve. It must be heated, under steam-pressure, to a temperature of 240° Fahr. or upward, in order to thoroughly destroy the germs of fermentation. Cans of sweet corn or fruit, convex at the ends, show the presence of active ferments within. Fish and meats are prepared in a similar fashion, but there is a growing distrust of tinned receptacles, especially for salt or very acid articles of food, on account of the extensive adulteration of tin plate with lead. Glass cans are now much used in the home canning of fruits, though not adapted to the exporting or extended transportation of them. They are self-sealing, the cap screwing down air-tight upon a rubber ring. The only objection to them is their liability to break through unequal heating. This may be obviated by filling them with cold water, placing them in a vessel of water, and gradually raising the whole to a boiling heat. The cans may then be emptied of water and filled with the boiling fruit. The glass, thus treated, never cracks, and the cans will last for an unlimited time, if thus handled whenever they are filled.

Jellies and preserved fruits in bottles are often coated with a green mold, the result of a fungous growth. This may be prevented by pouring upon the surface of the fruit a small amount of a solution of the bi-borate or the salicylate of soda, or salicylic acid dissolved in alcohol; agents which do not sensibly impair the flavor of the fruit, but destroy fungi and bacteria.

FRUIT DRYING.—The drying of fruit is now performed in a far better manner than formerly. The fruit is peeled, sliced and freed from core or seeds, and then, as quickly as possible, placed upon the trays and deposited in a box or kiln filled with the fumes of burning sulphur mixed with borax. The sulphurous and boracic acids thus formed, partially saturate the fruit; bleach it to its natural whiteness, destroy germs, and prevent oxidation. The fruit is then dried by artificial heat, and the sulphurous and boracic acids escape during the process. Fruit so prepared, is said to be "evaporated"; it wonderfully retains its natural color and flavor, is perfectly healthful, and commands a far higher price than if dried as formerly.

The study of ferments and bacteria has as yet barely begun, and very many of the statements and assertions made in regard to these agents, must be accepted as tentative and provisional. But the discoveries thus far announced seem to be incomparably more important in their relation to the well-being of humanity than those which pertain to any other department of scientific truth. We may hope that agents will soon be discovered, capable of banishing all contagious and epidemic diseases from the earth.

VII. BREAD.

The cereal grains are the most important element in human food. Among these are wheat, rye, barley, oats, rice, and maize, or Indian corn.

Wheat is the most important of all the cereals. Its culture is rapidly increasing, and new wheat-growing regions, including India and British America, are being extensively developed. Means of transportation are also increasing and growing cheaper, so that wheat, once a luxury used by but few, is fast becoming the most universal, as it is the most perfect of all articles of human food.

Wheat contains starch, gluten, oil, the phosphates, and the fluorides, apparently in the best possible proportions for nourishing the human body. Starch and oil are fuels for the human furnace, gluten nourishes the muscular tissue, the phosphates are bone and brain food, and the fluorides furnish material for the enamel of the teeth.

The former method of preparing wheat for food included a process of grinding it between millstones, and separating the product, by means of rotating sieves, into various grades of flour and bran. In the "new process" the skin of the grain is rubbed off by means of suitable apparatus, and all the residue, including the gluten and phosphates which formerly went into the bran, is now crushed into a flour of the highest and most nutritive quality.

Graham flour is made by grinding the entire wheat-grain, the coarser and finer portions being mixed together.

Pearled Wheat is prepared by rubbing the skin off the grain in the manner described above, and polishing it by friction. This preparation of wheat is growing in favor as a breakfast-dish, taking the place of oatmeal.

Rye is extensively used as a bread-stuff in northern and north-western Europe, and was formerly, in combination with Indian corn meal, greatly consumed in New England, under the name of "rye and Indian bread."

This grain abounds in gluten, but, as compared with wheat, is deficient in starch and the phosphates.

Barley is the bread-stuff of high latitudes, as it ripens where no other grain will, in the short summers of the far north. It is scantily supplied with gluten, but makes a very satisfactory bread.

Oats, in the form of oatmeal, are everywhere growing in favor as a breakfast dish. Oats are deficient in starch, but especially rich in gluten and the phosphates. In Scotland, oatmeal is baked into large, hard cakes, which may be kept for several months, unimpaired in quality. In this country, the grain is thoroughly kiln-dried, ground, and mixed with wheat-flour. From this is prepared the oatmeal mush or porridge, a most palatable and nutritious dish.

Rice is the food of an enormous percentage of the human race. It is most abundantly produced in China and the Indies. This grain abounds in starch, but is deficient in gluten and the phosphates. Great quantities of rice, of the highest quality, are now produced in the South Atlantic and Gulf States, and it is growing into use, especially as a dessert dish.

Maize, or Indian corn, supplies a cheap and abundant food to the poorer people of Europe and America. This grain, though not wholly wanting in the other elements of nutrition, is especially rich in starch and a fixed oil. This oil speedily becomes rancid upon exposure to the air, and the process of decomposition goes on in direct proportion to the fineness of the meal, because the finest exposes most of its oil cells to the air. Hence maize is always coarsely ground, and is never prepared in large quantities, or for long keeping.

Bread-Making. Bread is made by various processes; among which the chemistry of the ferments plays an important part.

As stated above, *Torula*, the true yeast-plant, is never spontaneously generated. It has been used in leavening bread for many thousands of years.

It comes to us prepared in various forms for use. *Compressed yeast* is the nearly pure *Torula*, taken from the scum of brewers' vats, and sold in small cubes covered with tin-foil. This is very active when fresh, but putrefies if long exposed to the air. Yeast-cakes are dried tablets of corn or wheat meal, containing living cells of *Torula*. These are packed in air-tight cans, and retain their vitality for years. Fresh yeast is also continually transplanted from one bread-trough to another.

Into a paste of flour mixed with water or sweet milk, and blood-warm, the yeast-cells are introduced. They at once begin to multiply rapidly. The organic molecules of the grain are broken down and modified in form. The starch is partially transformed into gum and glucose, alcohol is generated, and $C\,O_2$ is set free in abundance. The gum and gluten of the dough tend to retain this, and it accordingly forms numerous bubbles, which cause the dough to "rise" rapidly. Enough flour is now kneaded in to make the paste firmer in consistence; it rises again, and is then baked.

The heat destroys the life of the yeast-cells, and drives off the alcohol in vapor. The carbonic acid is retained in the cells of the bread for a short time,

not acted upon
by the saliva.

but soon escapes by osmose. If eaten fresh from the oven, the bread is ~~digested~~ with the CO_2, which is carried into the circulation, and often produces headache, stupor, and gastric disturbance. When fairly ripened by exposure to the air for one or two hours, leavened bread is perfectly healthful. A portion of the material has been converted into alcohol and carbonic acid, but the remaining portion is more digestible than unfermented bread, owing to the conversion of the insoluble starch into the soluble gum and glucose. Yeast is likely to forever remain the favorite agent for leavening bread.

SALT RISING is made by exposing a paste of flour mixed with warm water or milk to the action of various ferments which enter it from the air. In this process, less alcohol is formed, there is less conversion of starch into gum and glucose, but carbonic acid is abundantly evolved, and a very light and white loaf is produced. This dries up much sooner than yeast bread, because the starch of the loaf has little power to retain water, compared with gum; it is not as digestible as yeast-bread, and the process of fermentation hastens on toward putrefaction. Hence, if not baked at the right moment, such bread is often sour and unpleasant in odor. The salt is not an active agent in this fermentation.

CHEMICAL AGENTS are used to make bread light, through the displacement of carbonic acid. Sour milk contains lactic and acetic acids. If bicarbonate of soda be added to a paste of sour milk and flour, these acids combine with the soda, forming the neutral salts, lactate and acetate of soda, and the CO_2 is set free. Such bread is probably more healthful than yeast-bread, when both are fresh-baked, as it does not hold the carbonic acid with the same tenacity; but it is almost worthless when dry, as the moisture rapidly escapes, and there is usually a disproportion between the amount of soda and the acid of the milk, so that one or the other is almost invariably in excess. Such bread is usually sour, or streaked with an unwholesome stain of soda.

BAKING POWDERS seek to remedy this by combining tartaric or phosphoric acid with bicarbonate of soda. They are mixed in the proportion of one pound of dry soda to two of the cream of tartar. If kept dry, these agents, though in contact, cannot react upon each other. A suitable proportion of this mixture is thoroughly incorporated with flour, water or milk is added, and a lively effervescence follows, the tartaric acid setting free the carbonic, and uniting with the soda.

Baking powders, if pure, form a useful and harmless mixture. They are much adulterated by the addition of the unwholesome drug alum. All brands containing this are semi-poisonous.

AËRATED BREAD is made by decomposing limestone with sulphuric acid, forming sulphate of lime, and setting free the CO_2; forcing water to absorb this gas under great pressure; mixing this aërated water with flour automatically, and moulding it into loaves while still under pressure; and, lastly, removing these loaves into the outer air. Upon the removal of the tremendous pressure of confined gas, these loaves at once "rise," through the expansion of the CO_2 within, and are ready for the oven.

This sort of bread could not well be manufactured in ordinary bakeries or homes, as the apparatus is cumbrous and costly. This process economizes material; none of the flour is converted into carbonic dioxide or alcohol, the gas necessary for raising it being obtained from the inexpensive sulphuric acid

Na_2CO_3 = sodium carbonate.
4 $NaCO_3$

and limestone; but it must be used when fresh, as, for reasons described above, it speedily becomes dry and hard.

Nitrate of Ammonia (H_4N, NO_3) has been used to aërate bread. By heat it is wholly converted into "laughing gas" and water, the gas speedily escaping by osmose. However, this and all ammonia-salts are of doubtful value in cookery.

"Gems."—Excellent bread may be made of unbolted wheat flour, slightly salted and sweetened, stirred into a stiff paste with boiling water, dipped into oiled iron cups, and quickly baked in a hot oven. Such bread is never very spongy and light, but it contains no carbonic acid or neutral salts, is perfectly healthful and palatable, and may be eaten when warm without any ill effects.

Indian Corn Bread raised with soda or yeast is healthful when newly baked, as the flinty particle cannot retain any large amount of carbonic acid. It is a nourishing and fattening food.

Pastries and Sweet Cakes are formed of various mixtures of flour, butter, eggs, sugar, and fruits. They are invariably unwholesome and difficult of digestion. The excessive use of these substances tends to make of the Americans a nation of dyspeptics. It is also true that the labor of preparing them so much occupies the time and thought of the housewife, as often to forbid needful rest or mental culture. The American Pie is responsible for many intellectual deficiencies and physical weaknesses.

VIII. ALCOHOLIC BEVERAGES.

Alcohol ($C_2 H_3 O$) is, as we have seen, produced by the action of ferments upon sugar. It is also built up, by a process of synthesis, from simpler compounds, and one form of it, Methyl, or Wood Alcohol, by the destructive distillation of wood. This fiery and acrid spirit is used as a beverage in some parts of the country, but almost all alcohol thus used is obtained by fermentation.

Beer. If barley be moistened and exposed to a gentle warmth, it begins to germinate. By the action of the ferment contained in each grain, called *diastase*, the starch is converted into gum and glucose, and thus rendered soluble.

After the process has continued to the proper point, the grain is dried and ground. In this form it is called *malt*. It is now gummy and sweet, and largely soluble. Warm water and yeast are added, and a violent fermentation sets in, with a disengagement of large quantities of carbonic acid, as indicated by the froth which appears on its surface.

After the desired degree of fermentation has been reached, an infusion of hops is added. This partially paralyzes the *Torula*, so that new cells are developed but slowly, and the liquid remains in a state of comparative chemical quiescence. It is now stored in casks or cisterns, and kept at a low temperature, sunlight being carefully excluded. The name *lager bier*, applied to this beverage, is from the German *lagern*, to lie: Enormous subterranean reservoirs of it are kept filled by many of our breweries. In the year 1881, the manufacture of beer in the United States amounted to about 500,000,000 gallons.

Ale is a sort of beer containing a larger percentage of alcohol than lager. The latter is said to contain sometimes no more than three per cent. ; the former as high as six or eight per cent.

Brown Stout, or *Porter*, is made of malt which has been smoked and scorched, so that the liquid is of a dark color. It contains a large percentage of alcohol, and is thus fitted to bear transportation to any desired distance. Bottled ale and porter, mostly manufactured in England, are in all markets throughout the civilized world.

WHISKY is made of wheat, rye, or maize, ground, fermented, and distilled. The ground and fermented mixture is called *mash*. In the distilling process, the mash is placed in huge copper retorts, and heated. The alcohol is vaporized, with water, fusel oil, and certain essential oils. These mixed vapors pass through a coiled tube called the *worm*, which is continually cooled with ice or cold water. The vapors condense into an acrid, ill-smelling fluid called *highwines*, having much of the odor of decay from damaged grains. To remove these evil odors and flavors, the highwines are *rectified*, or filtered through charcoal dust. This removes the offensive taints and odors ; it is now *whisky*, but the fusel oil remains. This is a very poisonous sort of alcohol, also called Amyl, having the composition $C_5 H_{12}O$. It is said to slowly escape from whisky kept in casks, being, in the course of years, absorbed by the wood, or decomposed.

Wine is produced by the crushing and fermenting of grapes. The skin of this fruit, when ripe, always contains, adhering to its surface, numerous cells of the ferment called *Saccharomyces Reesii*, which have been wafted through the air to their resting place. If the grapes are crushed, these cells, being immersed in the sweet juice, at once pass into a state of active growth and multiplication.

To make red wine, dark-colored, juicy grapes are selected and crushed by passing through narrow gratings or between rollers, or, as in southern Europe, by the pressure of bare human feet. The mashed grapes are then shoveled into vats, and there undergo a process of fermentation, in the course of which the coloring-matter of the skin is dissolved out, with the tannic acid and essential oils. After the alcohol is fully developed, the fermented pulp is pressed. The juice is now *claret*. It is put into tight casks, and after a few months into bottles.

WHITE WINES are made of lighter-colored grapes, which are pressed immediately after crushing. These contain but little coloring-matter or tannin. They are transparent, rather than white.

Champagne is generally made by mixing with white wine certain proportions of gum and cane sugar, and bottling immediately, firmly fastening on the corks with wire. A powerful fermentation follows, and usually many of the bottles are burst by the pent-up carbonic acid. The stronger ones remain intact, and are stored in cool cellars. Upon opening a bottle by cutting the wire, the wine flows out foaming. This wine is highly alcoholic, and causes headache and much social drunkenness.

PORT, ANGELICA, and MUSCATEL, are produced in southern California by pressing grapes which have dried on the vine nearly to the state of raisins. The juice ferments, but large quantities of grape-sugar remain undecomposed, and these wines are very sweet. In moister regions they are made by adding to one gallon of distilled spirits four gallons of *unfermented* grape-juice. Such mixtures are more properly called *cordials*, and are highly intoxicating.

BRANDY is produced by distilling the lower grades of wine. It contains alcohol, water, and essential oils.

RUM is produced by fermenting molasses, and then distilling.

GIN is made by soaking the resinous berries of the juniper in spirits, and distilling. It contains water, alcohol, and the essential oil of the juniper.

From any of the above, nearly pure alcohol may be obtained by repeated distillation. The small portion of water that remains in it may largely be removed by the action of quick lime, and *absolute alcohol* is left.

The above-named list includes the most important alcoholic mixtures. There are, however, others more local in their use.

CIDER is produced by crushing and pressing apples. The fermented cider may be distilled, making *apple brandy.*

PEACH BRANDY is produced by fermenting and distilling peaches. It abounds in prussic acid when first manufactured, but this is gradually dissipated and absorbed by long keeping.

KOUMISS is a sort of beer made by the fermenting of milk ; *metheglin* is made in a similar way from honey ; *perry*, from the juice of pears.

ALCOHOL is a powerful solvent and antiseptic, and hence is greatly used in medicine and the arts. A great variety of resins and other medical principles cannot otherwise be well dissolved or preserved.

Alcohol is not food, though possibly it may act as a fuel to the body, producing animal heat by its oxidation. It has a great affinity for water, and by absorbing it from tissues hardens the albumen of muscle and brain, diminishing all the vital powers. It produces a violent madness, if taken in sufficient quantities ; it destroys the moral sense, and causes a progressive and rapid ruin of mind and body.

The annual cost of alcoholic liquors to consumers in the United States is not less than $700,000,000 and is rapidly increasing. In 1881 the various breweries and distilleries of America produced ten gallons of beer and nearly three gallons of distilled liquors for every man, woman and child in America.

The direct cost of alcoholic liquors is, however, but a small portion of the actual expense. When we consider the enormous cost of wasted manhood, diminished power of production, pauperism, crime, police and insurance expenses, the actual added expense is beyond calculation. The continuance of civilization is seriously threatened by this and cognate poisons.

One remarkable feature of the alcohol habit is its progressive character. To produce the needed stimulation, the amount taken must be continually increased.

ADULTERATIONS.—The adulteration of alcoholic liquors is one of the saddest features of the case. In times when the hop-crop fails, various other agents, including the *Coculus Indicus*, a somewhat poisonous narcotic drug, are used in place of it. Even when manufactured according to the best methods, beer tends to stupefy the brain, to weaken the nervous system, and to induce a dropsical bloating of the tissues.

Imported European wines are almost universally "sophisticated." Especially since the general failure of the French vineyards, vast quantities of clarets are manufactured of various acids and chemicals, often colored with *fuchsine*, a poisonous extract from petroleum. The French brandy imported into this country is very generally spurious. Very cheap and vile whiskies are made of various drugs, including *Cannabis Indica*, or Indian Hemp, whose extract, in another form, is called *hasheesh*. This drug produces a temporary delirium, quite distinct from the intoxication of alcohol, and more destructive in its effects upon the nervous system.

The evil influence of alcoholics is greatly increased by the indiscriminate prescribing of them by physicians for various diseases. The habit of drinking them is easily acquired, and soon becomes almost unconquerable.

It is not too much to assert that nine-tenths, or ninety-nine hundredths, of all the clarets, sherries, port-wines, French brandies, and Holland gins, or mixtures bearing those labels, sold in the United States, are adulterated or wholly counterfeit. The effects of the alcohol poisoning, always sufficiently pernicious, are thus increased and supplemented by those of a multitude of agents intended to simulate alcohol in their methods of action, and to intoxicate men more cheaply than can be done by the use of alcoholics.

Among all political, social, and scientific problems presented for our consideration, none can compare in importance with those which relate to the enormous and growing use of poisons. Alcohol and tobacco should be classed together, as two of the most pernicious enemies of the human race. They are complementary to each other, each producing a craving for, and seeming need of, the other. The depressing poison nicotine creates a craving for the stimulating alcohol; and the converse is equally true.

It is the duty of every teacher, and especially of every instructor in science, to teach the plain truth concerning these pernicious agents, and to set a wise and worthy example in regard to their use.

IX. FLESH-MEATS AND OTHER ANIMAL FOOD.

Throughout the historic period, man has been a carnivorous being. He selects his food from among all the realms of animal life. In general, animal food is more stimulating, more digestible, and more readily assimilated than vegetable food. On the other hand it is more expensive, no more nourishing, and more likely to introduce into the system dangerous forms of parasitical life.

Butchers' Meat includes beef, mutton, veal and pork.

Beef is a perfectly healthful, nutritious and stimulating food. It contains fibrin, fat and a substance called *creatine*. This especially abounds in the syrup known as "Liebig's Extract of Beef," which is prepared by concentrating, through gradual evaporation, the broth of pure muscle. Creatine also abounds in beef tea. It is highly stimulating, but not highly nourishing. If a sick person attempts to eat dry bread, the stomach rejects it, being unable to digest or assimilate it. Beef broth, taken alone into the stomach, is but slightly nourishing. If both be taken together, with proper flavors and condiments, the broth stimulates the stomach to digest the nourishing bread.

Soups are made by putting beef into cold water, boiling long and gently, and seasoning with condiments and sweet herbs. The leg joints of beef make a palatable, but not very nourishing, broth, which is principally a solution of gelatine.

ROASTS and STEAKS should first be exposed to a high heat, and afterwards cooked gently. The intense heat coagulates the fibrin, thus retaining the nourishing juices. Beef cooked slowly, especially if fried in lukewarm fat, is hard, tasteless and innutritious.

MUTTON should be more thoroughly cooked than beef, as it contains a musky odor called *Hircene*, which is partially dissipated by thorough cooking, and obscured by proper seasoning. Mutton makes a soup inferior to that of beef, as it contains less of *creatine*, and of the fragrant principle called *Osmazome*.

VEAL is an immature flesh. It abounds in gelatine, the most elementary and least nutritious of the albuminoids. It is not very nourishing or digestible.

PORK is wholesome if the animal has been fed on purely vegetable food, has lived amid cleanly surroundings, and has not been over-fed. Swine fattened at slaughter-houses and distilleries are almost universally diseased or infected with parasites. The two terrible parasitic worms, *Tænia*, or tape-worm, and *Trichina Spiralis*, are often received into the human system from uncooked or partially cooked pork. The announcement made by the highest medical authority in America is very explicit: "Any person who places between his lips a particle of pork not thoroughly cooked, does so at the peril of his life." The meat should be heated through so thoroughly as to kill all germs and living parasites.

The trichina is a minute worm found coiled in a sac or cyst, in the muscular tissue, the "lean meat." Many thousands are often crowded into one cubic inch. If these cysts, uncooked, be taken into the stomach, the covering is digested, and the worm is set free. Each one produces myriads of young worms, which eat their way through the walls of the digestive apparatus, are carried in the blood currents throughout the body, and finally make innumerable cells in the muscles, brain, eye, even in the walls of the heart. They finally become quiet in these cells, and do no further harm. If the patient can endure the fearful drain upon the vital forces which accompanies the active stage of these worms, he generally lives on; but the percentage of death is great.

THE TÆNIA or tape-worm, in its larval or incomplete stage, is found in a cyst or sac in the fatty tissue of "measly" pork. If taken alive into the stomach, the cyst is digested, the worm attaches itself by hooks and suckers to the lining of the stomach, and begins to develop the innumerable joints characteristic of its structure.

DIGESTIBILITY.—The celebrated experiments made with St. Martin, show that boiled salt pork is one of the most indigestible of substances, requiring some five hours for the process; while soused pigs' feet is digested in one hour. Veal is slow and difficult of digestion. In general, pickled or dry-salted meats are less nourishing and digestible than when fresh. Salt meats or fish, canned in tin, are occasionally poisonous, on account of the presence of a mixture of lead with the tin. This forms poisonous lead-salts.

VENISON AND GAME BIRDS, excepting such oily ones as the wild duck and goose, are very digestible and healthful food.

FISH are becoming more and more universally the food of the world. As civilization advances and population increases, flesh meats continually increase in cost, owing to the restriction of pasture ranges. But the ocean remains undiminished, and the possibilities of artificial propagation are unlimited.

Fish are not so well adapted to nourish the human body as flesh-meats.

Nevertheless, certain species have a considerable nutritive value. The cod probably ranks first among food fishes in respect to abundance and intrinsic importance. The mackerel, salmon, herring, and many others, contribute largely to human sustenance, and the supply is practically inexhaustible. The salmon, and other fishes of the north-western coast of America, are very oily, and hence less digestible than most other species.

MARINE ARTICULATES, including the crab, lobster, shrimp and prawn, are relished by many, but form a somewhat doubtful contribution to our food supply. They contain acrid principles, poisonous to many stomachs.

THE MOLLUSCA, including the oyster, clam, and a few more, are of great and growing importance. The area adapted to the artificial propagation of oysters seems almost boundless, especially upon our south-eastern coast. Along the Atlantic seaboard, oysters are said to be the cheapest form of animal food.

Though not very highly nutritive, oysters are among the most digestible of all forms of food, especially if eaten uncooked. The large liver of this animal contains the needful solvent. The spawning season occurs during May, June, July and August, "months without an R in them," and during this season oysters are unfit for food, often being shrunken and diseased.

REPTILES furnish a few eatable species, including the turtle and iguana lizard, of the torrid zone. Among edible BATRACHIANS, the frog is the most important. Its large leg muscles furnish a palatable and healthful dish.

EGGS and MILK are closely related in their chemical composition and nutritive action to the other forms of animal food. Eggs are nearly identical with muscle in composition, but contain a larger percentage of sulphur. This may be perceived by its action upon silver spoons, which it speedily and wastefully coats with a black sulphide.

Eggs, like all forms of albumen, very readily decay, and are best when entirely fresh. They may be preserved for months in solutions of salt and lime. If eaten when fresh, and not over cooked, they are a very nourishing and perfectly healthful food.

MILK varies greatly in quality, according to surrounding conditions. It has a remarkable power to absorb odors, pleasant or the reverse. Nowhere is perfect cleanliness more imperatively demanded than in the dairy. It is also true that the germs of tubercle and other maladies abound in the milk of diseased cows.

Vast numbers of cows are kept at distilleries, and fed almost wholly upon "still slops;" and the filthy surroundings and improper nourishment speedily develop scrofulous and tuberculous conditions in flesh and secretions. The milk from such cows, especially if uncooked, is poisonous. Much of the mortality among infants fed upon "city milk" is doubtless owing to this cause. Milk is also much modified in quality by various perfectly healthful articles fed to cows. Leeks, onions and garlic so saturate milk with their peculiar flavors as to make it uneatable. White clover and carrots cause milk and butter to assume a beautiful golden color. Lucerne, the "alfalfa" of California, gives to milk and butter a peculiar salmon tint, and a flavor which impairs their market value.

Ordinary cows' milk contains some 87 per cent. of water, 5 of caseine, 3 of butter, and 5 of sugar of milk and various salts. The solid matter exists in a state of solution, excepting the butter, which floats as an *emulsion*, in minute globules. These globules tend to rise to the surface, but are somewhat retarded by the viscidity of the milk. The colder the milk, the greater this difficulty is; hence, milk is sometimes heated, to hasten the process. The cream then rises at once, but the butter is poorer in quality. Churning causes the fat-cells to coalesce into butter.

Ordinary creamery butter is made of the cream which first rises from the milk, and is often slightly colored with a vegetable yellow. It is then salted and moulded into rolls or packed in firkins. A certain percentage of borax is sometimes added to the salt, to increase its antiseptic effect. Butter needs to be preserved from all evil odors with most scrupulous care, on account of its remarkable absorptive properties.

Cheese is the caseine of the milk, usually mixed with the oil-globules, the whole being coagulated into curd, by the addition of a gastric ferment called *rennet*. The stomach of a calf, salted and dried, furnishes this. The germ-cells of the rennet spread rapidly through the milk, causing the particles of the caseine to cohere. The curd is then salted, put into a hoop, and powerfully pressed, in order to remove the liquid matter, called *whey*. Weeks or months of ripening are necessary in order to produce a high quality of cheese.

Lard Cheese is made of skimmed milk, a small quantity of lard or other animal fat being added to take the place of the cream. A fair quality of cheese is made in this way.

If milk be long exposed to the air, it receives the living germs of various ferments, sours and curdles, developing much lactic and acetic acid. In this form it is the favorite food of many people, especially among the Tartars. Sweet milk seems better adapted to nourish infants than adults, often producing, in the latter, stupor and biliousness; but sour milk is said to strengthen the digestive powers.

Oleomargarine is made of beef or pork suet, which is heated to a temperature of about 130° Fahr., the oil is extracted by powerful pressure, churned with sweet milk, colored with anatto, a vegetable dye, and moulded into rolls like butter. It is a perfectly unobjectionable article of food, if made of the fat of healthy animals, but its flavor will never cause it to take the place of genuine creamery butter on well-supplied tables.

X. ILLUMINATING AGENTS.

If a Bunsen burner be attached to a gas-jet, and lighted, it burns with a nearly invisible, but intensely hot flame. Hold in this flame a piece of cold porcelain or glass, and it is not blackened, but the glass speedily melts, and vaporizes with a yellow light.

Place a cool glass jar over and surrounding such a flame, and it is speedily coated inside with water, in fine globules. This is the result of the union of the hydrogen of the gas with the oxygen of the air, but what has become of the carbon?

Exp.—Support an inverted funnel upon a small iron stand. Let the upper end of it pass half-through a large cork, and connect with it a glass tube bent so as to pass through the cork of a bottle of lime-water, and below the surface of the liquid. Let this bottle be fitted with a suction-tube passing through the same cork. Now place the ignited Bunsen burner under the funnel, apply the lips to the tube, and draw the air from the bottle by a powerful suction. Instantly the vapors from the flame will be forced by atmospheric pressure through the funnel into the bottle, and will bubble upward through the lime-water, which turns milky, owing to the formation of carbonate of lime.

These experiments show that in the Bunsen flame both the hydrogen and carbon are consumed by the oxygen of the air, which is mingled with the burning-gas before combustion.

EXP.—Close the openings for the ingress of air into the Bunsen tube with the thumb and finger. The flame is now bright, like that of an ordinary gas-jet. Hold in this bright flame a bit of cold metal or porcelain, and it is instantly coated with soot, or carbon.

Hold over this flame a glass jar. It is at once coated with water-drops, as before.

We can now see that the brightness of the ordinary gas-jet or candle is due to the presence of small solid particles of carbon, not burned, but heated by the burning of the hydrogen. If these particles be burned, the flame is intensely hot, but no longer luminous.

THE WICK AND THE FLAME.—If we apply a lighted match to melted tallow, or to the standard lamp-oil, it refuses to ignite; but if we immerse one end of a wick in the oil, the liquid is drawn upward by a capillary attraction, and is so finely divided that particles of it are heated by the match-flame up to the point at which oxidation begins. Thus the lamp or candle is lighted.

When a candle begins to burn, the heat of the flame keeps a portion of the tallow melted in a little basin at the base of the wick; and this liquid is constantly drawn upward to feed the flame.

The candle is also a small gas factory. Before the tallow burns, it is vaporized, and the combustion takes place on the surface of the ascending column of gas. The bright flame is a hollow shell, the air being without, and the inflammable gas within. The hydrogen, and a portion of the carbon, are oxidized at the surface of the flame. The remainder of the carbon passes into the air, in fine particles.

The discovery of petroleum has made a complete revolution in the art of illumination. Formerly, candles made of tallow, and whale-oil, supplied most of the artificial light of our homes. Now these have comparatively fallen into disuse.

CANDLES were formerly made of tallow, melted and formed into rolls by dipping the wicks into it, or by pouring the melted fat into moulds, into which wicks had previously been inserted. Now the work is mainly done in large factories. The fat is separated into two or more grades, only the hardest, the stearic acid, being used for candles; the rest being worked up into soap.

The stearic acid candles are a great improvement upon the "tallow dips" of former times. Candles are also made of bees-wax, of paraffine, and of spermaceti, the hard part of whale-oil. Candles are, in many instances, a convenient form of illuminating agent, but they are costlier than kerosene in proportion to the amount of light they give us.

WHALE-OIL is so much more costly than kerosene, that it is but little used for illuminating purposes. The sperm oil, obtained from the head of the sperm whale, still supplies the lamps in many of our light-houses.

KEROSENE has become the almost universal substitute for all other lighting materials in the country home. Its cheapness and the great brilliancy of light give it the preference.

Kerosene must be burned with the aid of a glass chimney, in order to throw a strong current of air upon the flame. This chimney is an annoying and costly accessory of the lamp. In many families the expense of chimneys is greater than that of oil.

Bastie Glass is so called after the name of its inventor. It is made by moulding the glass in the usual fashion, and then hardening it in a bath of hot oil. Glass chimneys treated in this way are very strong, falling on the floor often without injury; but they seem to be in a state of extreme molecular tension, and oftentimes crack into fragments without visible cause.

X

Lamp Explosions always occur on account of carelessness. *Kerosene never explodes.* The vapors of kerosene, mixed with air, form a dangerously explosive mixture.

There is a great difference in oils, as to their power to form vapor. Light oil is more volatile than heavy, and kerosene mixed with benzine vaporizes with a dangerous facility. Such an adulteration has often occurred on account of the lower price of benzine.

Fire Test.—Put oil on the stove in a tin cup, and heat, occasionally testing with a thermometer. When the temperature has risen to 120° Fahr., apply a lighted match. If the oil in the cup takes fire, it should be condemned, as unsafe to use in lamps.

Flash Test.—The oil is heated, as above, to 100° Fahr., and a lighted match is brought near it. If there is a slight explosive flash, caused by inflammable vapors mixed with air, the oil is rejected. This is counted better than the fire test.

Added Precautions.—Keep the lamp full of oil. The large open space in the cavity of a half-emptied lamp is likely to become full of mixed vapors.

Use wicks that accurately fit the tube.

Do not blow down the chimney to extinguish the lamp, but turn down the wick.

Never fill a lamp while it is burning.

Never pour oil out of a can upon a fire. The can often contains mixed and explosive vapors.

A Common Imposition.—People are often imposed upon by peddlers, who sell at a high price, small packages of unknown materials, warranted to make oil non-explosive. The usual illustration is to pour a little benzine into a lamp, mix with it the mysterious preventive, and then light it in the open lamp. It always burns quietly without explosion, and thus the spectator is deceived into purchasing a worthless commodity. *Neither kerosene nor benzine can ever explode.* Their vapors mixed with air will explode, and no substance mingled with the oil can prevent this. The only real safety lies in the use of oil that will stand the 120° fire test, or the 100° flash test.

Coal Gas is now universally introduced into cities and towns, and the methods of handling it seemingly should be familiar to all. And yet we read every year of a large number of deaths caused by the blowing out of a gas flame, and allowing the suffocating, poisonous vapor to flow into a close room.

The Electric Light is yet in its infancy, but is becoming a powerful competitor of gas-light. It is much more brilliant, and has far more of the quality of sun-light. Nevertheless, it has many drawbacks in respect to convenience and portability.

Thus far, all attempts in the direction of an electric current produced by voltaic batteries, have failed to give satisfactory results. Electricity for illumination is always generated by means of the rotation of electro-magnets, in close proximity to large permanent magnets, according to the various plans adopted in the construction of the magneto-electric engines.

ELECTRIC LAMPS are of two general patterns. First, the Incandescent, or Edison light. In this, the current is carried by a copper conductor into a closed glass vacuum-tube, where the ends of the conductors are united by a horse shoe-shaped filament of carbon, made by charring a strip of bamboo. This is intensely heated, and becomes luminous, but does not burn, as there is no oxygen in the tube. Second, the "Arc Light." This is produced by bringing close together two strips of graphite, or hard carbon, and passing the current from one to the other. These carbon-sticks are not kept in a vacuum, and they waste away rapidly, making frequent renewals necessary. The "Brush lamp" is of this pattern.

This form of lamp gives more light, in proportion to the power expended, than the one first mentioned, and it is the favorite form of lamps for illuminating the streets and large halls, but it is too bright and too hot for use in the home. There the Edison lamp will be the favorite. At present it seems probable that electric lighting will be limited to the larger cities and villages. The apparatus is too costly for isolated dwellings.

LUMINOUS PAINT is a sulphide of calcium, made by heating together, in an air-tight retort, equal parts of sulphur and the lime of oyster-shells. This compound may be ground to powder, mixed with linseed oil, and applied like ordinary paint to the surface of houses and the walls of rooms. This paint has a remarkable power to absorb sunlight by day, and give it out gradually by night. After being illuminated for a time, it shines all night with a purplish glow, rendering all objects faintly visible. It is likely to be used extensively as soon as it is in the market at a moderate cost.

XI. RESPIRATION—ANIMAL HEAT—VITAL FORCE.

All animal life is maintained upon the sole condition of the incessant inhalation of oxygen. Let this cease, even for a very brief time, and the life of the organism ends.

Oxygen is obsorbed by all aquatic animals in the form of a solution in water. The "water atmosphere" includes all the forms of gaseous matter dissolved in the sea, oxygen being the most abundant. The water is, by weight, eight-ninths oxygen; but sea animals have no power to decompose water in order to utilize this element. They can only breathe the dissolved gas. They therefore absorb less of it than land animals, and their blood is correspondingly low in temperature. The gases are readily driven out by boiling the water. If it be boiled, and then cooled, a fish placed in it will speedily die of suffocation.

Terrestrial animals and men obtain oxygen directly from the atmosphere, of which it forms, by weight, over twenty per cent. It is supposed that the function of the nitrogen, which mainly makes up the remaining part of the air, is physical rather than chemical. It dilutes the oxygen, which would otherwise be too active, and assists in creating the amount of atmospheric pressure best suited to animal life.

The oxygen, passing into the lungs, is drawn through the walls of the air-cells, and into the blood, by osmose. A minute blood-vessel is connected with each air-cell of the lungs. The blood enters this tube from the right ventricle of the heart, charged with carbonic acid. This gas feels the adhesive attraction of the oxygen in the air-cell, and a portion of it passes through the membrane and mingles with the air, and, at the same time, a portion of the oxygen passes into the capillary, and mingles with the blood, which instantly flows back into the left auricle of the heart through the pulmonary vein. Thence it passes into the left ventricle, and is pumped through the arteries to all parts of the body. It is now red, sparkling, and actively vital. The oxygen seems to adhere to or saturate the blood corpuscles, and is thus carried into all the organs and tissues of the body.

The blood is sometimes called "liquid flesh." It is a clear fluid in which float the innumerable little disks, mostly red, each being about $\frac{1}{3200}$ of an inch in diameter, and seeming like an independent organism.

The tissues of the body are made up of very small cells. A cell is a minute sac, filled with a liquid protoplasm; though many of the cells seem to be masses of living matter without enveloping membranes.

It is not possible to explicitly state the influence of oxygen upon these cells, but it seems certain that a change occurs, parallel or similar to actual combustion. It is probable that those cells longest in place, having the least vitality and resisting power, are consumed, their molecules of albumen being broken up and reduced to simpler compounds with a release of heat and vital force. Thus, rapid breathing causes an increase of oxidation, and a corresponding development of force and heat. The force that works the muscle or brain, largely resides in the molecules of those organs. By use, the organs are consumed; and this consuming seems to be not essentially different from the development of power in an engine by the consumption of coals in its furnace. As a practical fact, mental activity burns the brain, and muscular activity is produced by a combustion of the cells of the muscle.

PRODUCTS OF COMBUSTION.—The O uniting with H forms water; with C it forms carbonic acid. The latter is exhaled through the lungs, and also through the pores of the skin. During the process, a portion of H unites with N, forming ammoniacal salts. Also, the O unites with the small proportion of P and S, forming acids which are excreted by the glands of the skin. These glands and other excretory organs, take their material from the blood contained in capillaries.

After intense exercise, the brain or muscle is sore and heated, the soreness arising, perhaps, because of the loss of material which it has sustained. The various waste products of combustion are emptied into the capillaries, which transmit them to the veins. The venous blood passes into the right auricle of the heart, thence to the right ventricle, and on to the lungs, completing the round of circulation.

The human locomotive moves by consuming itself.

The void left in the tissues is mainly filled during periods of rest. The blood, flowing through the tissues, everywhere builds its own living cells and plasma into the broken walls. Thus the brain, whose weight, by active exercise, was diminished at night, is rebuilt by the morning, and has increased in weight and in power to work.

This rebuilding seems to be done through the action of that portion of the brain which presides over the *involuntary functions*, such as respiration, circulation, and digestion. The master of the house, called the Rational Faculty, the Spirit, has done his work by using the force released through the burning of the materials of his house; but while he sleeps, the house-carpenter, who lives in the brain-cells guiding involuntary activities, goes forth to do all needful repairing.

Hence the necessity of abundant and perfectly uninterrupted sleep. Every student or manual laborer should sleep, if possible, eight hours out of each twenty-four. If the sleep be scanty and broken, the rebuilding work will be done unsatisfactorily;—the person will rise languid and weary.

Also, there must be no needless additional work imposed upon the vital forces. It is not well to take much food immediately before retiring for the night. This often produces a dreamy, imperfect sleep, interrupted by nightmares, and followed by languor and exhaustion.

All narcotics produce a stupor in which the action of the involuntary nerves is impaired, and the very purpose of sleep—rebuilding—is largely defeated. "Soothing syrups" and "cordials" never bring on a normal and beneficial rest.

The ventilation of sleeping-rooms should be perfect. It must be remembered that the rebuilding forces work, like the other bodily forces, through oxidation of material. Therefore, abundant fresh air must be constantly supplied. Florence Nightingale says, "People greatly fear to breathe the night air. But what air can be breathed at night, excepting night air?"

HOW TO VENTILATE.—Most dwelling-houses have no elaborate apparatus for ventilation. A window with adjustable sashes may be opened at the top and bottom, so as to afford a sufficient air-supply for one or two persons. Two windows, opened on different sides of the room, are still better.

CAUTIONS.—It is not well for a sleeper to occupy a space directly between two open windows. "Taking cold" will probably result.

The face of an infant is often covered with a blanket during sleep. No useful or healthful result follows. The child lies in a morbid stupor; it is asphyxiated by its own carbonic acid. Its lungs should be fed with pure air in abundance.

Shutting off the air-supply does not tend to keep the body warm. In sleep, as at other times, bodily heat comes from oxidation. If less than the usual amount of oxygen be inhaled, the bodily temperature is instantly lowered.

SLEEPING ROOMS.—A room on the first floor is not the most healthful. It is undoubtedly true that, during the night, all miasms and noxious vapors most abound near the surface of the earth, and are likely to invade the lower rooms of the house. The atmosphere of sleeping-rooms needs to be vitalized with sunshine during the day. The best place for a sleeping-room, especially in a malarial locality or a crowded city, is the sunny side of the house and in the upper story.

NIGHT ATTIRE.—The human body sends forth its waste from every pore. During the day the clothing, especially of men actively exercising, is saturated with these exhalations; hence, no article of clothing worn during the day should remain upon the person at night; and it would be better to keep all the day-garments in a separate room during the night. Single beds are the best for all people. The young and healthy should never occupy the same bed or room with persons debilitated through sickness or age.

WARMING OF CHAMBERS.—The open grate or fire-place is not economical of fuel, but it is a powerful ventilator, owing to its chimney-draught. An "air-tight" stove, full of burning coal, closed up and undergoing a scanty and slow combustion, is one of the most efficient of enemies to health. It pours C O, carbon monoxide—an actively poisonous gas—from every fissure of its plates. Furnace-registers often send into our chambers air which has been drawn from foul alley-ways and damp basements. Air saturated with disease-germs is thus presented to the lungs in the most passive and non-resistive condition of the body—sleep. Air for the supply of furnaces should be brought in pipes from the highest part of the house-wall.

DRESS AND RESPIRATION.—The physiological purpose of respiration is measurably defeated, and every sort of displacement, debility, and organic disease induced, through the detestable deformities which Fashion imposes upon her votaries.

The deformities of the Flathead or Chinese belle are harmless trifles compared with those produced by the tight dressing of the waist and chest. If the action of the heart and lungs be impeded, every function of the system is at once disordered. Headache, neuralgia, indigestion, faintness, consumption, and every form of organic disease follows the use of the tight corsets, stiffened with steel or whalebone; and there is no compensatory result, for the cultured sense of beauty is shocked by a deformed waist, as powerfully as the economy of health is disturbed by it. A tight corset was never yet worn by a person of a perfectly and symmetrically refined taste or scientific knowledge. It is the infallible badge of both ignorance and incomplete perception of beauty.

ILLUMINATION AND RESPIRATION.—The atmosphere of rooms is rapidly vitiated by illuminating agents. At the best, quantities of carbonic acid are formed in the process of combustion, whether of lamps, candles, or gas-jets. The night-light in sick-rooms is often a kerosene lamp, turned low so as to produce a dim light through slow and imperfect combustion. This is one of the most noxious of illuminants. CO_2, CO, and various unwholesome vapors are poured into the air from such a lamp. One burning freely in an adjoining room, with the door slightly ajar, would be preferable.

XII. CLEANSING.

DIRT is wittily defined to be "matter out of place." The mold of the garden or field is dirt when it strews the kitchen floor. Butter or tallow is food in its proper place; it is dirt when adhering to our hands or our clothing.

The substances of which our homes, persons, and garments require to be cleansed, may be conveniently grouped in three general classes:—

1. Such materials as are soluble or suspensible in water.
2. Those which ~~are soluble~~ [illegible] in soaps and alkalies.
3. Such stains as require special chemical agents for their removal.

WATER is the nearly universal solvent. We constantly remove from our persons and surroundings a great variety of substances, dissolved or mechanically suspended in water. This process can hardly be considered a chemical one.

We have, however, one exceptional class of compounds. The fixed oils, collectively known in the laundry as "grease," refuse to dissolve in pure water. They must be acted upon by soap or the alkaline bases, before solution in water is possible.

SOAP may be classed as a salt, formed of the bases soda or potash, combined with the fat-acids called Oleic, Stearic and Margaric.

Formerly "soft soap" was made in almost every house, of lye leached from wood ashes, united with the refuse grease of the kitchen by a process of boiling. Such soap always contained an excess of potash, and was very effective in doing its work. At present, hard soap is generally used. In this the base is soda, obtained by decomposing sea salt. In such soaps there is no excess of alkali.

Much of the water available for laundry uses is "hard." Such water usually contains bicarbonate of lime ($C_a O, 2 C O_2$), ~~which is freely~~ soluble. It may be "broken" by adding a solution of potash, washing soda, ammonia, or lime. In using the three agents first named, one molecule of $C O_2$ is withdrawn from the bicarbonate of lime, forming a soluble salt by union with the newly-added base. Carbonate of lime remains, but this is only slightly soluble in water, and is quickly precipitated, leaving the water soft and pure. If quick-lime be added to hard water, the dissolved material is wholly converted into calcic carbonate, and precipitated.

$CaCO_3 + CO_2 = CaCO_3$

Hard water decomposes soap; the excess of $C O_2$ unites with the soda or potash, setting free the fat-acids, which float in a greasy scum upon the surface of the solution. Hence the importance of using rain-water, or some other form of soft water, for cleansing purposes.

Grease is the most important agent to overcome in the process of cleansing. The skin of the human body excretes oil everywhere, and clothing is likely to become greasy by contact with most of the materials used in our daily work. All sorts of dirt adhering to clothing are combined mechanically with oil and grease.

Alkalies in solution combine with grease, forming a soluble salt. Soap also unites with it, forming, according to Chevreul, "double fat-acid salts"; the portion of alkali thus released from its combination in the soap, uniting with the grease, and the whole mixture being washed away in solution or mechanical suspension.

In practice, the hard water must first be "broken" by using some of the alkalies above-named. Next, it must be heated, and the soiled fabrics rubbed in contact with soap containing a little free soda; the emulsion called soap-suds is wrung out by hand, or pressed out between rubber rollers; the garments are boiled to remove stains, and then dried in the open air, if possible. The above statements refer to uncolored linen and cotton goods.

STAINS.—Boiling generally removes grass-stains. These, and all other organic discolorations, may be removed by the use of chlorinated water in boiling the goods. A few drops of "Labarraque's Solution" ($N_a O C_l$), or of chloride of lime in solution, will greatly facilitate the bleaching process. But this must be used in small amount, and with caution, as an excess of it consumes the fabric. It must never be used in washing colored goods, as it attacks all dyes.

FLANNELS.—In washing flannels, special precautions must be observed, owing to the tendency of woolens to shrink by the "felting" or matting together of the fibers. Such garments, by careless or ignorant handling, grow smaller with each return from the laundry. To prevent this, flannels may be washed in hot suds, and then rinsed in clear hot water. The essential point seems to be, to wash and rinse in water of about the same temperature.

Bluing is an operation demanded in modern laundry processes. Indigo was formerly used, but soluble mixtures of Prussian blue are now generally substituted. This substance contains iron, and is readily decomposed by various bases. Unless the rinsing of garments is thoroughly done, rust-spots are likely to appear upon them after using these dyes.

KEROSENE and all other volatile petroleum oils may readily be removed from garments by using a hot flat-iron.

IODINE.—Stains of iodine may be removed by sponging with a solution of hypo-sulphite of soda. This article may be found at all drug stores.

NITRATE OF SILVER forms a black stain, not easily removed by ordinary cleansing processes. Cyanide of Potassium removes this stain at once; the two colorless and soluble compounds, Nitrate of Potash and Cyanide of Silver, are formed and washed away. But this agent (K C[illegible]) must be handled with great care, as it is one of the deadliest of all known poisons.

INK STAINS are of two sorts: those containing iron, and those made of aniline. The first named may be removed by the use of oxalic acid, which forms with the iron a colorless and soluble oxalate. The aniline inks readily yield to the action of chlorine. Labarraque's solution or that of calcic chloride, greatly diluted, will destroy the color. But all the above named bleaching-agents are very caustic, and must be removed from the cloth at once by dipping in water. The last trace of the acid may be destroyed by adding a little ammonia to the water. Soaking in sweet milk will remove fresh ink-stains from colored or white fabrics.

Red iron-stains are easily removed by the use of dilute muriatic acid, with the above precautions. It is best to rinse in dilute ammonia.

In no case should these agents be applied to dyed or printed fabrics, until a small specimen of the cloth has first been tested. The dyes are often as sensitive to bleaching agents as accidental spots or stains are.

COLORED CLOTHING, as cassimere or broadcloth, is sometimes discolored by contact with acids. The black dye becomes red. Sponging with ammonia-water will, in most cases, restore the color.

To remove grease from colored fabrics, pure benzine is one of the best of agents. If the expense is not too great, the article should be wholly immersed in the liquid; otherwise, a shaded ring is likely to mark the edge of the spot moistened.

Dry clay or Fuller's earth may be placed on the under-side of the grease-spot, a piece of paper laid upon it, and a hot iron passed over it. The grease is melted, forced downward by the vapors which the heat generates, and absorbed by the porous material.

SOOT, freshly fallen upon a carpet, may be removed by sprinkling corn-meal over it, and then sweeping.

The following compound has proved most admirable for the removal of grease from cloths:—

Washing ammonia	1 pint.
Chloric ether	1 ounce.
Alcohol	1 "
Glycerine	½ "
Powdered white Castile soap	2 "

Add enough water to make four pints of the mixture.

Garments sponged with the above are speedily cleansed of oily impurities.

Silver is best cleansed by adding a little washing ammonia to hot water. It may be rubbed with precipitated chalk. Porcelain should be treated with a solution of ammonia.

Disinfection and *Deodorization* are processes closely related to cleansing, and have their place even in the laundry. All garments likely to contain the germs of infectious or contagious diseases, should be made harmless by steeping in a bath of chlorine or dilute carbolic acid. The writer is cognizant of cases in which laundresses have been inoculated by infected garments with the most horrible of blood-poisons, which entered the system at points where the skin was slightly abraded.

Kitchen sinks and drains, slop-tubs and buckets, vermin decaying in inaccessible places, and all similar causes of offense, may at once be rendered odorless and harmless by the use of the agents named above;—chlorine or carbolic acid.

HINTS.

Ammonia freely dissolves brass, and should not be used in cleaning it.

Faded aniline blues and purples, may often be restored by steeping in dilute acetic acid, or vinegar.

Grass-stains, when fresh, may be dissolved away by the use of alcohol. The green color is due to the vegetable dye, chlorophyll, which the alcohol dissolves.

Mildews are often incorrigible. If not too deeply rooted, they may be removed by repeated washings in chlorinated water, followed by drying in the sunlight.

Braided straw, cloth, and various articles may be bleached by sulphurous acid. Moisten and hang in a tight box or closet, in which sulphur is burning.

XIII. DRINKS.

Properly speaking, water is the only beverage. All other liquids and mixtures owe their value as quenchers of thirst to the water they contain.

It is still an unsolved question whether perfectly soft water, or that which is made hard by the bicarbonate of lime, is best for the human system. Persons accustomed to either one of these seem to prefer that one. Perfect freedom from bacteria, noxious gases, and earthy sediments, seems to be the only condition absolutely essential.

Potable waters are obtained by the storage of rain-water, by digging wells, and by using the natural outflow of springs and streams. In large cities the first two methods are not very available. Both air and soil are contaminated with impurities, which the water freely dissolves. Water must be conveyed from a distance by means of aqueducts; and our civilization so multiplies defilements, that the problem of properly supplying cities with water is one of great and increasing difficulty.

As ordinarily gathered upon roofs, and conducted into tanks and cisterns, rain-water washes down germs of ferments, and absorbs gaseous impurities. This is especially true during the warm weather of summer. After remaining for a short time in the tank, an active fermentation sets in, and odors of putrescence are developed. Such water, abounding in organic matter, is likely to become infested with animalculæ.

Rain-water caught during the winter has less organic matter, but often contains impurities. In all cases, health and comfort will be greatly promoted by filtering the water before storing it.

The best cisterns for rain-water are constructed of masonry cemented with water-lime, are sunken below the surface of the earth, and are so closed above as to perfectly exclude dust and insects.

A filter is a small additional cistern, opening through a pipe into the first, and filled in the following order, commencing at the bottom, with materials arranged in regular layers: (1) pebbles and coarse gravel; (2) coarse sand and fine sand; (3) a coarse tow or linen cloth; (4) pulverized charcoal, one foot in depth; (5) another coarse cloth; (6) six inches sand and gravel. Planks or large flat stones should be placed in a position to receive the shock of the falling stream of water. The upper layer of sand must be removed, and fresh charcoal substituted for the old, after six months' use.

Water gathered in this fashion is almost chemically pure, perfectly healthful, and very grateful to the palate. It will remain pure indefinitely. Such a cistern may be placed on a height above a dwelling, so that the pressure will carry the water through pipes to the upper stories. In regions where the annual rain-fall is 36 inches, a roof 40 by 50 feet will gather 6000 cubic feet, or about 45,000 gallons. This gives a supply of nearly four barrels per day throughout the year—an ample supply, in most homes, for drinking and cooking purposes. The surface for gathering rain may be constructed of inexpensive, even of semi-refuse, materials.

Wells are often reservoirs of filth. Owing to the imperfect construction of the upper walls, and the lack of any sort of a cover, dead insects, mice, and often larger animals, pollute the water. Atmospheric dust and impure surface washings have free access. Well-water is far too often tainted with putrescence, and loaded with the germs of disease. Typhoid fever, dysentery, phthisis, and, in marshy ground, malarial disease, may frequently be traced directly to the use of impure well-water. It is not too much to say that the universal substitution of filtered rain-water would diminish the above-named diseases fifty per cent.

Springs having an abundant flow are usually purer than dug wells; but it must be remembered that these are fed by rain-water percolating through the overlying soil, and that the sources of contamination are numerous. Our rivers are fast coming to be mere sewers, but the constant flow and agitation of swift streams tend to aërate the water, and to oxidize impurities. The experience of a century has shown that the water of the foul and muddy lower Mississippi is far more healthful than that of wells sunk in the marshy soil of the delta.

Wells dug in a sandy soil, near a human habitation, with no impervious strata above the water, are almost universally impure. The liquid contents of sinks and sewers filter through such a soil into the natural reservoirs of water below. Instances are on record in which the water of a well has been poisoned by the contents of a vault more than a hundred feet distant. Water which seems pure to eye and palate, often is loaded with disease-germs as deadly as a solution of arsenic.

Boiling water kills bacteria, expels the gases of decay, and makes the water more healthful.

All sewage, and the slops of kitchen and laundry, should be conveyed far away from the home in impervious pipes of metal, cement, or glazed porcelain.

Wells should be examined and thoroughly cleansed at least once a year.

Water-pipes supplying the home should be of iron; never of lead or zinc.

It is better that sewage pipes terminate in an open ditch or ravine, than in a covered cess-pool.

COFFEE.—The chemical and physiological effects of this substance have been heretofore discussed (p. 10). The proper preparation of it as a beverage remains to be considered.

The coffee-berry is often roasted in such a fashion as to be almost worthless. Slow drying in half-heated ovens, or charring in a nearly red-hot roaster, are far too common.

It should be roasted uniformly, by continual stirring or rotating. It should be removed from fire when a grain of it breaks freely between the teeth, without any sensation of toughness.

Coffee is often boiled too much. The very best decoction is made without actual boiling, by steeping in water heated nearly to the boiling-point. It may be clarified, and an improved flavor imparted, by stirring it with a cup of cold water, into which an egg has been beaten, and afterward pouring hot water over it.

Various patent coffee-boilers are now in the market, which have a strainer of wire gauze or linen. These are often cheap and entirely satisfactory.

Coffee well-made, in moderate quantities, is a refreshing and not necessarily unhealthful drink. One cup of it, at breakfast, will seldom cause any unpleasant effects. Cream improves its healthfulness by neutralizing the tannic acid.

TEA is more subject to poisonous adulterations than coffee (see page 9). It must be selected by the purchaser with intelligent care, if he would be sure of a palatable and healthful article. Good tea may be known by its fragrance, the flavor of the leaf, and its lack of positive color. Only painted and poisonous teas are ever of a bright green color. The range of tints in genuine tea is from black to a dull olive-green.

Tea is best when the infusion is made with soft water. It should be placed in a *hot* teapot—one teaspoonful for each person at the table—and covered with boiling hot water, but must not be permitted to boil, as this would dissolve the tannic acid, and dissipate the fragrant essential oil. Milk is even more necessary in tea than in coffee, on account of the greater abundance of tannin. Properly selected and prepared, tea is a refreshing and healthful drink, and is especially acceptable to brain-workers.

Chocolate is prepared by boiling the seeds, roasted and crushed, in an equal mixture of milk and water. The broken chocolate-beans are called *nibs*, and represent the purest form of this product. Chocolate, pulverized and pressed into cakes, is often adulterated with peanut-flour, and other foreign substances.

Kola.—Much is now expected of the African kola-nut, as a substitute for coffee. It is roasted, ground, and prepared like chocolate. It is said to contain more caffeine than coffee does, to be palatable, nourishing, and healthful, and to have the power of destroying the thirst for alcoholic drinks.

XIV. THE TOILET.

The desire to be beautiful is a natural, and not necessarily an evil, human longing. The danger lies in the tendency to use improper toilet accessories. The character and effects of cosmetics, hair-dyes, and similar agents, come properly within the purview of this work.

The materials used to disguise the natural complexion by an artificial white coating are:—

1. Powdered starch.
2. Carbonate of magnesia.
3. Chalk, or carbonate of lime; also called "Lily White."
4. Oxy-chloride of Bismuth, called "Pearl Powder."
5. "Flake White," a nearly pure carbonate of lead.

Nos. 1, 2, and 3 are harmless, except that they tend to dry and roughen the skin. This is especially true of all forms of lime.

The Bismuth preparation is unsafe in an atmosphere of sulphurous odors, where it rapidly changes into a black sulphide. An indiscreet entrance into a gas-factory, or approach to a warm sulphur-spring, will often produce astonishing changes in an artificial complexion. The blackened powder, which has been rubbed deeply into the pores, is difficult to remove.

No. 5, a refined white lead, is an active and destructive poison. Lead salts are rapidly absorbed by the skin, and their continued use produces facial paralysis, and the peculiar hideousness that arises from the inability of the facial muscles to express mental states. Lead also causes great gastric irritation, "painters' colic," and the premature ruin and break-down of the system.

There are many face-washes and powders, "Cremes," and "Blooms," classed among patent and proprietary mixtures, which are advertised as "containing nothing injurious to the most delicate person," but which nevertheless abound in white lead. The use of such agents is not only silly but suicidal.

The artificial blooms ordinarily used are carmine and rouge.

Carmine is a red dye obtained from the cochineal, a species of scale-louse infesting the cactus in Mexico. This dye is entirely harmless.

Rouge is an extract of the safflower-plant. It is also harmless.

Among savage and semi-civilized people, vermilion is extensively used as a face-paint. It is most pernicious in its effects. Among the American

Indians, the prevailing habit of painting the eyelids with vermilion has produced an extraordinary percentage of eye-disease and blindness.

No person of refined or cultured tastes needs to be told that good health and kindly thoughts are the best beautifiers. The use of artificial complexions is a sure proof of ignorance, childishness, and a lack of correct taste. Abundant exercise, pure air, regular and sufficient sleep, simple, nutritious food, frequent bathing, much useful and cheerful work—these are the true cosmetics.

HAIR-DYES owe their effect to the following agents:—

1. Lac sulphur.
2. Nitrate of silver.
3. Salts of lead.
4. Tartrate of bismuth.

The sulphur dyes are not injurious to the health, but they tend to form the offensive gas, sulphureted hydrogen. The odor of a scalp thus treated is always unpleasant, no perfume being entirely able to conceal it.

Nitrate of silver is caustic, and injures the health of the hair. The various preparations of lead, including the "leaden hair-brush," are all actively poisonous. Various "Vigors," and "Hair-tonics," contain acetate of lead. "Naquet's Hair-dye" is a tartrate of bismuth. It is probably harmless.

All of the above must be continually applied, else the growth of the hair will reveal the real color. Many persons have been utterly ruined in health through the incautious or ignorant use of leaden hair-dyes. It is better not to fight against nature in regard to these matters. White hair is, in its proper season, as beautiful as any other.

BLEACHING.—Various agents are used for the purpose of bleaching dark hair to lighter color. The sulphite of soda, and the peroxide of hydrogen ($H_2 O_2$), are the most important. These are not especially injurious, but the use of them is costly and laborious, and the application must be constantly renewed.

BALDNESS.—Premature baldness is sometimes caused by the action of parasitical animalculæ, which perforate and destroy the hair-bulb. The following compound is often prescribed for this:—

1 oz. castor oil.
2 " glycerine.
2½ " kerosene.
1 " tincture of cantharides.
6 " perfumed alcohol.
1 " bay rum.
Mix and shake thoroughly before using.

This is applied in minute quantities for the purpose of destroying such parasites. Its application demands a thorough rubbing with a stiff brush.

WARTS and MOLES.—A compound called "Ethylate of Sodium" is used for removing warts, moles, and birth-marks. It is prepared by dissolving metallic sodium in absolute alcohol. The solution is accompanied by an active effervescence, and a soapy substance remains. This should be applied to the excrescence, and allowed to remain for one or two minutes. It may then be sponged off, and a plaster applied. In a short time the objectionable growth will be cast off.

The TEETH suffer and decay for various causes. One of the most common is indigestion, with acidity of the stomach. In all cases, the *immediate* cause of decay is a bacterium which invades the tissue. Mercurial medicines often loosen the teeth by destroying their bony sockets, called alveolar processes.

The deposit called Tartar is a mixture of phosphate of lime with the mucus of saliva. It is a most annoying and repulsive accretion, causing ulceration and decay of the gums, and a fetid breath. It should be removed, as often as necessary, by a competent dentist. A clean stomach and frequent cleansing with the brush will best preserve the teeth. Castile soap and powdered orris-root are excellent dentifrices.

The following is a delightful compound of a more elaborate character, which may be used as a dentifrice:

Prepared chalk, 8 oz.
Borax, 2 drachms.
Orris-root, ½ oz.
Castile soap, 2 drachms.
Oil of Wintergreen, 20 drops.
Rub thoroughly in a mortar.

Arsenious Acid, the "arsenic" of commerce (A_{2s} O_2), is sometimes swallowed in small doses for the purpose of whitening the skin. The drug Belladonna is taken into the stomach, or rubbed into the eye, in order to dilate the pupil. Of all the follies of fashion, the use of these agents is among the worst, in its destructive effect upon health. The arsenic-eating habit is especially difficult to overcome, as a cessation of it is said to produce the symptoms of violent arsenical poisoning. The drug is more rapidly ruinous to the health than morphene.

Bay rum is an alcoholic tincture of the essential oil of *Myrcia Acris*. It is said to destroy the microscopic parasites, sometimes living in the roots of the hair.

Hair oils are generally made of lard oil, or olive oil, variously perfumed, and often digested in alcohol. They tend to become rancid if applied too freely.

Vaseline, an extract from petroleum, is the best of all hair oils, resisting this tendency to putrescence. Cocoa-nut oil is also growing in favor.

It is better to avoid the use of hair oil, if possible. The healthy scalp, if left to itself, secretes an abundance of oil in certain glands which open into the sheath of the hair-bulb. If artificial pomades are used, the work of these glands measurably ceases.

HAIR-WASH.—A solution of borax in soft water is an admirable wash for the hair. A very dilute solution of ammonia answers a similar purpose; but a concentrated solution makes the hair dry and harsh, and tends to bleach it. An egg stirred into tepid water is one of the best washes.

PERFUMES are usually prepared as follows: The leaves and petals of fragrant plants are placed between sheets of paper oiled with sweet, fresh butter. This rapidly absorbs the essential oils, and after it is saturated, the butter is digested in alcohol. "Cologne-water," "Jockey-club," and many fashionable perfumes, are made of these alcoholic tinctures, variously compounded.

Powerful perfumes have been said to ozonize the air, and render foul

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odors less harmful; but their use can never be a satisfactory substitute for cleanliness, and any excess in this respect is in bad taste.

BATHING.—This is by far the most important of all the processes of the toilet. Oil, the products of perspiration, and the scales of dried cuticle, are perpetually accumulating upon the surface of the skin. *Dandruff*, so annoying to some people, originates in this way. Scratching the scalp with the sharp teeth of a comb corrects the matter for the moment, but only increases the irritation and consequent secretion. Frequent washing with a solution of borax or ammonia is the remedy. One week is the longest time that should ever elapse without a complete bath.

Hot water, though less stimulating to the skin than cold water, is the most efficient solvent and cleansing agent. Soft water is indispensable. Washing ammonia is a delightful addition to the bath, but it should be very dilute. Soap is the active solvent of all oily accretions.

The soaps in market are often made of rancid or putrid grease, and the evil odor of such agents remains upon the skin, very persistently. A pure quality of soap is indispensable.

The hot bath, while thoroughly cleansing, tends to lassitude and languor. It should be taken immediately before retiring, that the system may have time for a thorough reaction before resuming active duty.

BAD BREATH.—This is often caused, as stated above, by diseased or decaying gums or teeth. Indigestion or diseased lungs may be the cause.

The breath of a healthy person should be odorless. The gaseous or vaporous products of respiration include only water and carbonic acid. A foul breath always indicates the presence of ferments, causing disease or decay.

At present, the various compounds of carbolic acid are the best remedies known. There is an alleged double salt called "sulpho-carbolate of soda," which is perfectly harmless, and not unpleasant to the taste, and which has remarkable power in correcting the breath. Good dentistry, a simple and digestible diet, and abundant exercise in fresh air, will generally correct this most annoying and offensive condition.

In case of consumption, and certain blood-diseases, the breath and secretions of the mouth are very active poisons.

Many infants die from the results of caresses. The membranes of the mouth are exceedingly absorptive. Nothing can be more detestable than the back woods method of redeeming pledges in certain games of forfeits. There is sometimes death in a kiss.

A ROUGH SKIN may be organic and incurable; or it may be caused by drying winds, the excessive heat of the sun, and many other agencies. Washing with water causes a temporary relief, but often leaves the skin in a worse, rather than a better state. The following is a soothing and comforting application:

Heat 2⅓ oz. of glycerine, and dissolve in it 3 drachms of boracic acid. Add cologne spirits, 2⅓ oz , and aqua camphor, 3 oz.

SKIN-BLEACHERS.—Chlorinated waters have the power to diminish the effect of tanning. A poultice moistened with *Labarraque's Solution*, dilute, will whiten the skin upon which it is laid. But all such preparations leave the face more sensitive to the action of sunlight, and likely to be worse tanned on the next occasion.

Freckles may be removed by the application of powdered saltpetre, or nitrate of potash and pulverized borax, in equal parts, moistened with water. The application must be several times repeated.

A poultice of meal, honey, and the white of egg, applied to the face for many nights in succession, is said to be an effective skin-bleacher.

Pimples are caused by impure blood—often made impure by bad food, and a lack of exercise and ventilation. Candy, pastries, and strong coffee, are enemies to the complexion. Let the diet be simple and nourishing; take much open-air exercise; abundantly ventilate the sleeping-room; take such medical advice as will insure the activity of all vital functions; frequently cleanse the skin with hot baths; if the blood be purified by these means, the skin will acquire a real beauty, far higher than the poor counterfeit produced by covering with paint the eruptions arising from a corrupted blood.

Depilatories.—These are agents used in removing superfluous hair. They are generally strong and acrid caustics. It is said that solutions of camphor or ammonia, as strong as can be borne, will remove superfluous hair without pain or injury.

$Pb\text{-}CO_3 = \underline{Pb\text{-}O}, CO_2$

XV. PAINTS AND VARNISHES.

In order to protect wood or metallic surfaces from decay, they are often covered with paint. This is made, usually, of various metallic oxides mechanically combined with *drying oils.*

Linseed oil, extracted from the seed of flax, is one of the most useful of these, as it has the power to absorb oxygen from the air, and harden into a firm coating over the painted surface, ~~or in~~ and the pores of wood.

White Lead, or carbonate of lead, is the principal agent used to give body, firmness, and durability to the paint. *White zinc,* or zinc oxide, is also much used, although it is inferior to white lead.

Colors.—Various substances are added to the mixture of oil and lead, for the purpose of coloring it. One of the most common of these is *ochre* or *sienna,* a clay containing iron oxides. If such clay be heated, the protoxide of iron, $F_e O$, is changed to the sesqui-oxide $F_{e2} O_3$, and its color is changed to red. By means of these clays, various shades of red, yellow, and brown are produced.

Lamp-black, or soot, gives us various shades of black and dark slate.

Bright green paints contain the compound of arsenic and copper known as Scheele's green. A duller and cheaper green pigment is chrome-green $C_{r2} O_3$.

A very bright red paint is made by using vermilion, or sulphide of mercury (H_g S). The best quality of this is obtained from China.

Blue colors are produced by the use of Prussian blue, or *smalts,* a glass colored by cobalt. The latter gives the brightest and most agreeable tints.

Dryers are volatile oils added to hasten the hardening of the paint. These are benzine and spirits of turpentine, the latter being preferable. Where these agents are used, it is believed that the coat of paint is not so firm or durable.

Rubber and *Balata* are often added to house-paints, in order to make a more glassy surface. These gums also increase the durability of paint. A small proportion of water-glass, or soluble silicate of soda, is said to heighten these effects.

By blending these various colors, innumerable tints and shades are produced. The "rubber" or water-proof paints, ready mixed for use, are now found in all markets, and they are cheaper and better than the average workman is likely to produce from the original materials.

Varnish is a mixture of various gums and resins in fixed or volatile oils.

Fixed oil varnishes have the greatest durability and lustre. They are prepared by heating linseed oil to a temperature of 300° Fahr., and then dissolving in it gum copal or some similar resin. This varnish dries slowly, but deeply penetrates the pores of wood, and forms a firm and durable surface.

VOLATILE OIL VARNISHES are made by dissolving the resins in spirits of turpentine. This solvent rapidly evaporates, leaving a thin, brilliant coat of the resin; but this is less durable than the above.

ALCOHOL VARNISHES are solutions of the various resins in alcohol.

[illegible]

XVI. DYES AND INKS.

METHODS OF DYEING.—There are two general methods by which dyes are applied to cloth or leather. The first method can hardly be considered a chemical process. It is the result, rather, of mechanical adhesion. The materials to be dyed are merely steeped in a solution of coloring-matter, and the dye permeates the fibres. Only the aniline dyes, obtained from coal-tar or crude petroleum, can in this way be made permanent. All other dyes, applied in this manner, may speedily be washed away.

MORDANTS.—The great majority of the dyes forming "fast colors" are affixed to the fibres by means of a class of substances called mordants. This word is derived from a Latin word signifying to bite. The salts of aluminum, iron, tin, copper, and chromium, form the principal mordants.

If a decoction of any coloring-matter, as cochineal, madder, or logwood, be added to a solution of a suitable mordant, a chemical union of the two substances occurs; a substance called a "lake" is formed, which is usually an insoluble precipitate, and cannot be used as a dye. But the art of dyeing consists in forming the insoluble lake *in the pores of the fibres to be dyed.*

Thus, white cotton cloth may be steeped in a hot solution of sulphate of iron, or copperas, which saturates its fibres. It is now soaked in lime-water. The lime decomposes the iron sulphate, the acid leaving the iron and combining with the lime, forming calcium sulphate, or gypsum, whose nearly insoluble particles are washed out of the cloth. Now the cloth has acquired a yellowish tint, being permeated by the oxide of iron, which is a mordant. The fabric is now plunged into a solution of logwood, and speedily turns black. An insoluble lake, of iron and logwood dye, has been formed in the pores of the cloth. The iron has *bitten* the dye into the cloth.

In calico-printing, as many different mordants as there are to be colors are applied by the action of blocks standing out like type upon the surface

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of revolving cylinders. These blocks are cut in various forms, so as to impress corresponding figures upon the cloth, and are continually moistened with the mordant solution, by means of revolving brushes and rollers. Small elastic rollers press the cloth against these cylinders, as they revolve, and thus the calico is printed with mordants only. After it has become dry, it is dipped in a solution of madder, cochineal, or some similar dye, which adheres to the mordants, but may be washed away from the spaces between them. Thus one color-solution will appear in as many different tints as there are mordants used in printing.

After the calico has been printed with mordants, dipped in the color-bath, and washed to remove the dye from the spaces between the figures, it is dipped into a starch-solution, and pressed smooth by hot metallic rollers.

The variety of materials and processes used in dyeing is too great to be exhaustively discussed here. However, a very few illustrations may be given.

COCHINEAL DYE.—To dye flannel scarlet, it is first thoroughly cleansed to remove all grease and extraneous matter; it is then soaked in a solution of the chloride of tin, to which cream of tartar is often added. These two salts act as a mordant. After the cloth is fully saturated with them, it is washed and steeped in a solution of cochineal. The dye combines with the mordant, forming a scarlet lake, and the liquid becomes nearly clear.

Only vessels of wood or of metallic tin are suitable for this process. If the former be used, it must be kept hot by steam-pipes. If vessels of iron or copper hold the dye, their oxides combine with it, and the color is spoiled.

OTHER RED DYES.—Madder, a plant until recently extensively produced in Europe, contains a red-dyeing extract called Alizarin. This, combined with salts of alumina, furnishes a most important red dye. Recently, this substance has been principally extracted from petroleum-tar.

OTHER COLORS.—Quercitron bark is a favorite material for yellow dyes, and indigo extract for blue. A vast variety of shades and tints may be produced by blending dyes and mordants.

ANILINE is an alkaloid extracted from petroleum, resembling ammonia in its re-actions, but more complex in structure. Various acids combining with it, act as mordants. It gives a remarkable series of colors, including red, blue and purple.

INKS are liquids containing coloring-matter in a state partly of solution and partly of mechanical suspension. Water, sulphate of iron, and the tannic and gallic acids extracted from nut-galls (excrescences growing on the oak, caused by insects), are the principal ingredients of ordinary black ink. The gallic acid combines with the iron, forming a black precipitate, and the particles are held in suspension by dissolving a little gum-arabic in the fluid. The following are the usual proportions:

Bruised nut-galls, 1 lb.
1 gallon boiling water.
Sulphate of iron, 5½ oz.
Gum-arabic, ½ oz.

Steep the nut-galls 24 hours, then strain and add the other ingredients.

A few drops of clove-oil or creosote should be added, to prevent mouldiness.

PURPLE INKS.—These are mostly solutions of aniline. It is said that these are less durable than black inks.

RED INK.—The best red ink is an ammoniacal solution of cochineal. The following is a satisfactory formula:

Hot water, 1 pint.
Powdered cochineal, 1 oz.
Spirits of ammonia, ½ pint.
Gum-arabic, 5 grains.

MARKING INK depends, for its permanency, upon the fact that nitrate of silver is readily decomposed by the action of light when in contact with organic substances, the nitric acid entering into new compounds, and the silver being converted into a black oxide. When first made the solution is colorless; hence it is a common practice to add some coloring substance as a convenience in writing. The following will be a satisfactory preparation:

Carbonate of soda, 22 parts.
Distilled water, 25 parts.
Silver nitrate, 17 parts.
Ammonia, fluid, 24 parts.
Gum-arabic, 20 parts, dissolved in sixty of water.
Sulphate of copper, 33 parts.

This ink is first blue, and afterward jet black.

INVISIBLE INKS.—These are solutions that are colorless until acted upon by heat, or some other special agency.

Chloride of cobalt forms such a solution. It is invisible until the writing is heated, when the letters appear in a fine green color. green

Writing made with the acetate of cobalt appears of a beautiful blue when heated.

XVII. HOUSES AND FURNITURE.

LOCATION.—Other things being equal, the country is better than the city as a place for a home. The air and water are likely to be purer; sunlight is more accessible; children can have more abundant exercise, and are less exposed to temptations.

A site of moderate elevation is better than a valley. Lands sloping toward the south, and sheltered on the north, are to be preferred. Low valleys are always frosty and often malarial. The tops of high hills are likely to be windy and bleak, and such sites are less easily supplied with water.

A porous soil gives the best drainage, and insures dry cellars; but wells should not be dug for the water-supply through such soils in the immediate vicinity of barn or out-houses. Many cases of disease occur through the poisoning of water in this way. Impurities often penetrate hundreds of feet through a porous soil.

BUILDING MATERIALS.—Brick and stone will always be the favorite material for the walls of houses. In cold climates, brick may be laid so as to form a double wall, with an air-space of perhaps an inch between the inner and outer layers. Such walls may receive a coat of inside plastering directly upon the brick without condensing the moisture into frost in cold weather.

Partition-walls in houses usually consist of two layers of wooden laths covered with plastering. These hollow walls are a refuge for vermin, and a dangerous screen for fires. Plans have lately been devised, by which solid partitions of paneled wood are substituted for lath and plaster. These are more expensive, but also more durable and permanently satisfactory.

The proper treatment of floors is a matter of great importance. Carpets are always reservoirs of filth, and of the germs of disease. The ingrain carpet, woven in open meshes, allows dirt to sift through it, and accumulate on the floor below. The body Brussels carpet has a firm, impervious web, with a thick mass of vertical fibres, forming the pile, woven into it. In this plush-like mass, dust accumulates in surprising quantities. Carpets are usually nailed down, and remain for six months or a year, constantly gathering an increasing amount of impurities.

A good body Brussels carpet, lined and laid down, costs some $2.50 per square yard. This amount of money would pay for a floor of tessellated wood, firm, polished, and almost indestructible.

The one objection to this sort of a floor lies in the fact that it is colder and more noisy than a carpet. It is, however, cleanly, tasteful, and healthful.

An excellent compromise may be made, by finishing off with contrasted woods a breadth of perhaps three feet around the sides of the room, and covering the plain square in the center with a movable rug. This may be held down by small metallic rings fastened to the under-side of it near the edge, which may be slipped over the heads of brass screws, sunk into the floor. To give greater elasticity, these rings may be fastened to the carpet by loops of extensible rubber ribbon. Such a rug will not easily be displaced or disarranged, and may be taken up and beaten clear of dust as often as may be necessary.

Wall Papers are much used, but are of doubtful hygienic character. The green-figured paper often contains arsenical paints, and the paste or glue used in fastening the paper to the wall tends to putrefy in damp weather. It is probable that the origin of many cases of diphtheria and typhoid fever might be traced to the decayed and bacteria-breeding pastes of wall-paper.

The gay colors and figures of paper-hangings are very attractive to the eye; but they soon become tattered, and cannot be commended for healthfulness or permanency.

Cellars are a necessity in cold climates, but are often sources of danger to health. Each autumn the cellar is filled with a miscellaneous store of fruits and vegetables, which are often allowed to remain until they decay. Thus the cellar breeds the germs of typhoid and dysentery.

As spring approaches, the contents of the cellar should be thoroughly examined, and all useless and decaying material removed. It would also be well, with the coming of warm weather to purify the air by scattering chloride of lime.

Sewerage is a matter of prime importance. Every house should be provided with means of removing all sources of impurity.

Fresh, dry earth is a powerful absorbent of noxious odors, and may be daily used, with great advantage, in privy-vaults. Nevertheless, the use of water will always be the principal method of removing impurities.

The New York Board of Health has published a series of recommendations upon the subject of sewerage, from which the following items are extracted:

1. Every house or building must be separately and independently connected with the main sewer.

2. The house-sewer must be made of iron, with joints calked with lead, or of hard, glazed, cylindrical earthenware pipe, whose joints are filled with hydraulic cement.

3. All pipes must have a fall of ½ inch to the foot. There must be no sharp bends, narrow places, or interior projections of cement or other materials, capable of causing obstruction. All pipes carrying water from a kitchen sink must be at least two inches in interior diameter. Sewer-pipes carrying the general sewage of a house must be at least four inches in diameter.

4. All waste-pipes must be provided with a "trap" to keep sewer-gas from entering rooms. This is usually in the form of a vertical curve, which always remains full of water. From below this trap, a ventilating air-pipe must be carried above the roof of the house.

5. Vaults must be ventilated by a vertical air-shaft, not less than 2½ feet square, extending above the roof, and so covered as to exclude rain, while allowing the free escape of air.

In the country home, similar precautions must be observed, and especial care taken to avoid polluting the source of the water-supply of the house.

Sewage may be carried into the sea, into some open ravine or ditch, or upon tilled lands, where it has value as a fertilizer of the soil.

SHADE-TREES are often planted too closely about the house. Dense foliage promotes the growth of mildews, keeps the air damp, and hinders ventilation. The house needs a daily sun-bath. Shade-trees should be far enough away to permit this.

BEDS.—A considerable portion of each twenty-four hours is passed in sleep. The position and furniture of the sleeping-room must be carefully considered.

The sunny side of the upper story of the house is the best place for a sleeping-room.

Mattresses are made of woven wire, of strips or disks set upon steel springs, of sacks filled with feathers, wool, curled hair, shoddy, or lint of woolen rags, *pulu*, or fibre of the palm-tree, husks, straw, and some other materials.

The use of feathers is diminishing. *Pulu* absorbs dampness in wet weather. Shoddy, made of miscellaneous woolen rags and decayed garments, can hardly be commended as a material for beds. A mattress of clean fleece wool or curled hair, resting upon one of woven wire or steel springs, is perhaps the most perfect bed. Woolen blankets, which may be occasionally washed, are the best bed-covering.

Beds and sleeping-rooms should be thoroughly aired each morning, the windows being open and the sheets fully exposed for an hour or more.

COOKING UTENSILS are usually of iron, sheet-tin, copper, white-glazed ware, and granite-ware. Copper is not a satisfactory material for this purpose, on account of the poisonous character of its oxides and salts. The chloride of copper is formed by the contact of salt food, and vinegar unites with it, forming the acetate. Salt or acid food should never be allowed to remain long in copper vessels. The "greening" of cucumber pickles is a process of copper-poisoning.

Iron oxide is perfectly harmless, but tends to darken the color of fruits cooked in iron vessels.

Sheet-tin, if not contaminated with lead, is the material of satisfactory though short-lived cooking vessels.

White-glazed iron vessels often contain arsenic in their porcelain enamel. The granite-ware is made by coating iron with a dark, heavy glazing. This is a cleanly and inexpensive material, and probably contains no harmful ingredient.

XVIII. ANÆSTHETICS.

CHLOROFORM, SYMBOL.	$C\ H\ Cl_3$	
ETHER, "	$C_4\ H_{10}\ O$	
CHLORAL HYDRATE...	$C_2\ H\ Cl_3\ O$	
NITROUS OXIDE......	$N_2\ O$	*Laughing Gas.*

CHLOROFORM is prepared by distilling alcohol with chloride of lime. It is a clear and very volatile liquid, of a fruity, agreeable odor, and a sweetish taste. It is extensively used in surgery, as a means of producing temporary insensibility.

If perfectly pure, bad effects seldom result from the use of chloroform. It is said that during the Crimean War, in the hospital at Scutari, near Constantinople, over 40,000 "capital" or very important operations were performed by the aid of chloroform, without any evil results. Nevertheless, occasional sudden deaths, occurring while under its influence, are reported. These are variously attributed to heart-disease, an enfeebled nervous system, and impurity of the drug.

Certainly a substance so potent ought not to be trifled with. No person should be treated with it, except by competent medical advice.

It is usually administered as a vapor. The specific manner in which it influences the nerves and brain, is not well explained.

ETHER is prepared by distilling alcohol with sulphuric acid. It is similar to chloroform in its effects, but acts less promptly and powerfully. The precautions given above, apply equally to ether and to all the anæsthetics.

CHLORAL HYDRATE is formed by the action of pure dry chlorine upon absolute alcohol, and subsequent combination with water. *Chloral*, the product of the first-named reaction, is a pungent, oily liquid, which will blister the human skin. When water is added, the mass becomes hot, and soon crystallizes into a white solid, the *chloral hydrate*. If heated, this substance vaporizes and re-solidifies without any change of composition.

Medical journals inform us that the use of this drug as a temporary reliever of pain is greatly on the increase; that it is especially used by women to soothe headaches, neuralgias, and similar ailments; and that the effect is even worse than that of the opium-habit. We cannot evade the consequences of violated law. Regular habits, simple and nutritious food, and abundant exercise, fresh air, and sleep, will generally make the use of narcotics and anæsthetics unnecessary.

LAUGHING GAS is obtained by decomposing nitrate of ammonia by heat. A little of the salt is placed in a flask or test-tube and gently heated, the whole of it being converted into nitrous monoxide and water.

$$N\,H_4,\;N\,O_3 = N_2\,O + 2\,H_2\,O.$$

For medical use, it is generally mixed with one-fourth its amount of oxygen. When inhaled, it causes a temporary delirium, which usually manifests itself in fantastic gestures and acts. The subjects of it dance, sing, laugh, or weep. If the inhalation be continued, the patient becomes insensible.

Laughing gas is much used in dentistry, to keep the patient from feeling pain, and injurious results very seldom occur.

The various anæsthetics, wisely and cautiously used, are a great boon to suffering humanity; but in ignorant hands they are dangerous in proportion to their power for good.

XIX. POISONS AND THEIR ANTIDOTES.

Among the various substances classed as Poisons, there are a few which are universally abundant and accessible, being used to destroy vermin in our houses and fields. Arsenic, Strychnine, and Cyanide of Potassium belong to this class of agents. Morphine and the various opiates, being constantly used in medicine, are also accessible, and liable to be used for murderous or suicidal purposes.

Strychnine and the Opiates have been fully discussed under the head of "The Vegetable Alkaloids."

ARSENIC, as used in commerce and medicine, generally comes to us in the form of Arsenious Anhydride ($A_{s\,2}\,O_3$), a white powder, having a sweetish and metallic taste. Its presence may be detected in materials vomited from the stomach by the use of "Marsh's Test," described in the first part of this work. Its symptoms are fully described in the various medical works.

REMEDIES.—1st, emetics or the stomach-pump. These should be used for every sort of poison. A pint of warm water, containing a little salt and mustard, will generally have the desired effect. Ipecac, tincture of lobelia, and tartar emetic, are also powerful emetics. After the operation of the emetic, give large doses of the hydrated oxide of iron, and the white of eggs, or fresh milk. The red rust scraped from any piece of iron exposed to air and moisture, is the hydrated ferric oxide demanded. Arsenic is powerfully caustic and corrosive when large doses are used. It destroys the membranes of the digestive apparatus. Hence, it is not possible, by the use of any antidote, to prevent a long continuance of soreness and suffering.

The use of arsenic in small doses, as a cosmetic, is a habit much practiced in Europe and America. It produces a fictitious plumpness of tissue, through the accumulation of lymph, which the proper vessels are unable to carry away; and the skin changes to a ghastly whiteness. Speedy and complete physical ruin is certain to follow this habit, if persisted in.

CYANIDE OF POTASSIUM is much used in the destruction of gophers, and other burrowing vermin. It is one of the swiftest and deadliest of poisons. No remedy is capable of preventing its almost instantaneous action.

OXALIC ACID is much used in the arts, and may be taken by mistake. The remedy for this is some sort of a harmless alkali. Bicarbonate of soda, chalk and magnesia, are excellent antidotes.

ALKALIES, taken in excess, are to be neutralized by the use of mild acids. Vinegar, and citric and tartaric acids are proper to use in such cases.

INSECT BITES AND STINGS are greatly relieved by the use of alkali washes. Ammonia, greatly diluted, and solutions of soda, are excellent for this purpose.

The bite of the largest spiders, including the tarantula, and the sting of the centipede and scorpion, are treated by the use of alcoholic spirits and the alkalies. One drop of aqua ammonia in a spoonful of water forms a dose to be repeated at frequent intervals. Large doses of brandy or whisky are usually administered at the same time.

SERPENT-POISONS are more active than those of insects, but the treatment is the same. It is asserted that very large draughts of the alcoholic liquors fail to produce intoxication during the operation of snake-poisons.

It seems to be true that the venom of serpents is closely related in its nature to the poison of Septicaemia. It is essentially a bacterium, or ferment, consisting of cells which develop, one from another, and multiply with terrible rapidity, coagulating the blood, and destroying the function of all the organs. It is probable that the value of alcoholic liquors lies mainly in their antiseptic action.

HYDROPHOBIA is a more subtile and terrible poison than any of those described above. It is a bacterium, self-reproductive like yeast, and rapidly destroying the brain and nervous system.

The only preventive hitherto known is excision or cauterization; the flesh about the wound is cut away with a knife, or burned with a hot iron.

Pasteur, the eminent French microscopist, announces that he has now developed a peculiar virus with which any person may be inoculated, so as to be perfectly protected against the bite of a mad dog. This remedy is a modified form of the hydrophobia poison itself. It is produced by inoculating various other animals by the poison of hydrophobia; as a result of which, the nature of the poison is so modified that it completely protects, without seriously injuring, the patient. Its action is like that of vaccination to prevent small-pox.

POISON OAK is very abundant in many parts of the Pacific Coast, and produces a poisonous effect, always very distressing, and sometimes fatal.

Prof. T. J. Burrell announces that the poisonous principle is a bacterium, which abounds in the waxy excretion of the leaf, and often in the surrounding atmosphere.

The best preventive is oil or glycerine, rubbed over the skin before exposure to the poison.

Bathing in a solution of common salt and carbonate of soda, as hot as can be borne, seems to be the most effectual method of relief, after the poisoning has occurred.

XX. INSECTICIDES, AND DESTROYERS OF VERMIN.

In order to protect the products of his own labor, man is compelled to wage war upon a great variety of invading animals, and especially insects.

At least five species of insects are very annoying in the home—flies, fleas, cockroaches, bed-bugs, and carpet-moths.

Flies are hatched in filth, and are very dirty and annoying insects. The most effective destroying agent is arsenious acid, dissolved in sweetened water. "Fly-paper" is saturated with this poison, and may be soaked in small saucers of water, placed near some window. It will quickly destroy all the flies. The "Persian Insect-powder," or "Buhach," is also very efficient. It is made of the petals of the plant called *pyrethrum cinerarifolium,* dried and powdered. This plant is extensively grown near Stockton, Cal. It has an aromatic essential oil, harmless to man, but deadly to insects.

Bed-bugs infest crevices in the walls of houses. Benzine sprayed into their holes is very deadly. Corrosive sublimate dissolved in alcohol is also effective if the wood-work of bedsteads be sponged with it. "Persian Insect-powder" strewed about a bedstead will destroy or repel the insects.

Carpet-moths are often very annoying to house-keepers. A small-winged moth deposits eggs around the margin of a carpet, or in the fur of a cloak, and from these eggs small larvæ or caterpillars are hatched, which cut the fibres, and make cocoons of them.

If fine-cut tobacco, benzine, or camphor, be scattered under the carpet, near the walls, the moth will seldom deposit her eggs. Sponging the carpet with salt water is said to be effective. Pressing it with a hot flat-iron, near the wall, destroys larvæ and eggs. If doors and windows are provided with fly-screens, the moth cannot make an entrance into the house.

Fleas are very annoying in certain localities. "Persian Insect-powder" scattered in a bed or about a carpet is a certain remedy.

Cockroaches are often troublesome in houses occupying damp situations. They may be destroyed by the use of red wafers. These are made of a paste of rice, colored with vermilion, or sulphide of mercury—an active poison. The rice-paste is greedily eaten by the cockroaches, and the vermilion does the desired work.

In the work of the farm and garden, we are confronted by numerous insect enemies. A few may be specified.

The grain-weevil infests the granary in warm climates. Persian Insect-powder, strewn among grain-sacks, is an effectual remedy. It also banishes ants from their usual haunts.

Aphides, or plant-lice, are very annoying in the greenhouse and garden. A small red mite, or spider, is equally annoying, attacking greenhouse plants, rose-bushes, and certain sorts of fruit-trees. The most satisfactory treatment is to spray with carbolic soap-suds. One fluid-ounce of carbolic acid, mixed with five gallons of laundry suds, will make a very satisfactory wash. The bark-louse, or coccus, is destroyed by a solution of one pound of potash in two gallons of water.

The scab on sheep is caused by a minute tick, or acarus, which burrows in the skin. This may be destroyed by dipping the sheep after shearing, in a wash prepared as follows:—Boil for several hours in five gallons of water, one pound of sulphur, and one of quick-lime. The two unite, forming a soluble sulphide of calcium, which is deadly to the insect. Baths of sulphate of copper, and of tobacco, are used for the same purpose.

A similar insect, burrowing under the human skin, causes the loathsome disease called itch. The wash above described, or an ointment made by mixing common sulphur with lard, will produce a prompt cure.

RINGWORM is produced by a fungous organism, not an animal, working in the fine hairs of the skin. Borate of soda, or commercial borax, in solution, will be found an effective wash.

The various beetles feeding upon the potato-plant may be destroyed by arsenical mixtures. The most effective of these is the arsenite of copper, called Paris Green. This substance may be mixed with several times its weight of fine dust, or dissolved in water, and sprinkled over the plants.

Powdered hellebore, or the Pyrethrum (Persian Insect-powder) will destroy the squash-bug and similar insects.

Ordinary poultry are much infested by certain species of lice. It is well to occasionally whitewash their house with a mixture of water, lime, and carbolic acid. Fumigation by burning sulphur in the house is very useful, and sulphur should be often mixed with their food.

Mosquitoes are destroyed or stupefied by the Pyrethrum. It may be puffed through the air in a fine dust with the aid of the small bellows that are sold with each package;—or it may be placed upon any heated surface, as a stove or shovel, and the essential oil will instantly be diffused through the air, with deadly effect.

Rats, mice, squirrels, and gophers may be destroyed by the following:—Mix together with one gallon of wheat, one ounce of thoroughly pulverized strychnine, two pounds of sugar, and one quart of water; after the grain is fully coated with the mixture, it should be dried in the sun. All predatory animals will eat this greedily, and be poisoned by the strychnine.

Three ounces of arsenious acid may be used instead of the one ounce of strychnine.

A very effective phosphoric poison is prepared as follows: Prepare a very thin paste of flour and water; put into this the sticks of phosphorus, and gradually heat, constantly stirring. After the ingredients are thoroughly mingled, wheat should be stirred in. The object is to coat the surface of the grain with the phosphoric mixture. It is now cooled and gradually dried, stirring and adding a little coarse meal to separate the wheat-kernels. This is a useful article to feed vermin, but should be kept from all danger of igniting buildings, and should never be scattered over the fields in a dry season.

XXI. CHEMISTRY OF PLANT-GROWTH.

Vegetable fibre mainly consists of three elements, Carbon, Hydrogen, and Oxygen, combined in the proportions $C_6 H_{10} O_5$. Starch, sugar, gum, and glucose are essentially isomeric with woody fibre, and a perpetual round of processes whereby one of the substances is converted into another, may everywhere be observed in the economy of plant growth.

GERMINATION OF SEEDS.—Seeds consist mainly of starch. This is stored up in the thick cotyledons, or seed-leaves, for the purpose of nourishing the germ of the future plant. Thus, if the outer skin be peeled off from a bean or pea, two thick, starchy, leaf-like masses are found within, holding between them the *plumule* and *radicle*, or germs of the sprout and the root.

If a seed, as a grain of wheat, be exposed to warmth and moisture, it swells, softens, and turns sweet. The starch is turned into glucose. As starch, it is insoluble in water at ordinary temperatures; but, if turned into glucose, it becomes soluble, and capable of nourishing the plumule and radicle. This conversion is effected by means of the ferment called *diastase*, which is stored up in the seed, and which warmth and moisture render chemically active. The starch of the seed is thus transformed, dissolved, and changed into leaf-cells and woody fibre.

MAPLE SUGAR.—During the winter, the starch and wood-cells of the root of the tree are changed into sugar. This, dissolved in water, forms the sap of the tree, which rises through the fine tubes of the white or sap-wood. This sugar flows into the buds, and causes them to expand into leaves. After the spring foliage appears, the flow of sweet sap ceases.

CORN-SUGAR.—At a certain stage of its growth, the pithy stalk of ordinary Indian corn is full of sugar. This is converted into the starch of the growing seed. After the grain is fully formed, the sweetness of the stalk disappears; its tissue becomes fibrous and tasteless.

ROOTS AND TUBERS.—The sugar-beet is a biennial. It cannot complete its growth in a single season; in the autumn, its leaves are usually killed by the frost. In order to form a second crop of leaves, sugar is stored up in the root. Thus, in the second spring, the sugar is converted into leaf-cells and the starch of seeds.

The sweet potato forms no seeds; it annually blossoms, but ages of high culture have destroyed its seed-producing power. Sugar is stored up in the root, and spent in nourishing the sprouts which grow from it when it is planted in the spring.

The Irish potato stores up starch instead of sugar; and as this is a less soluble material, the Irish potato is less subject to decay, and may be longer preserved than the sweet potato.

CANE SUGAR.—The southern cane, like the sweet potato, probably because of high culture, has no power to produce seed. It stores up sugar like the corn-stalk, but in greater abundance. This is retained unchanged until the stalk is planted, when sprouts grow from the joints which feed upon the sugar.

FUNCTION OF LEAVES.—The root and leaf absorb CO_2 and H_2O from earth and air. The chemical force of the sun's light, operating in the leaf, decomposes these, and forms the gummy sap which flows downward toward the root, between the wood and the bark, where it is converted into the wood-cells of new layers of growth.

FERTILIZERS.—Beside the compounds named above, there are in plant-tissues small quantities of nitrogenous materials and mineral compounds which must be formed out of other substances than carbonic acid and water.

The N compounds, such as gluten and vegetable albumen, are found in some leaves and all tubers and seeds. The leaves of all plants are bathed in an atmosphere of nitrogen, but have probably no power to absorb or assimilate it. They can obtain it in an available form only by decomposing ammonia ($H_3 N$). To furnish this, decaying animal matter is extensively applied to growing plants.

All woody tissue is strengthened and made rigid by the various silicates. Silica abounds in most soils, but it needs to unite with the metallic bases in order to become soluble. Potash and lime are added to soil in order to form the soluble silicates. Without these, no firm vegetable tissues could be formed; hence the fertilizing value of leaves and wood ashes.

All seeds, especially the cereal grains, contain the phosphates. These especially abound in the germ, and crops of grain rapidly exhaust the soil of these substances. Hence bone-dust, containing much phosphate of lime, is a valuable manure for wheat.

The great value of guano and of stable manure, lies in the fact that these are rich in ammonia and the phosphates.

Sulphate of lime, or gypsum, is very slightly soluble, and seems to have but a small place in the vital economy of the plant. Nevertheless, it has long been known that many plants grow better when treated with "plaster." It is suggested that its great value lies in its power to absorb ammonia from the atmosphere, and give it out to plants.

Snow is also a powerful absorbent and solvent of ammonia. A heavy coat of winter snow fertilizes the northern grain-fields.

Summer-fallowing, or frequent plowing of the soil without planting a crop, has a similar effect. The porous and moist soil absorbs ammonia.

Clover, and some other plants, send their roots very deeply into the earth, bringing up potash and the phosphates from below. If the green crop be plowed under it decays, its ashes are added to the soil, and ammonia and carbonic acid are set free and absorbed by the soil, enriching it greatly.

Irrigation.—Water, poured upon the surface of clayey soils, tends to harden them into a mortar-like mass. Sub-irrigation, by means of porous pipes laid under ground, is the best way to moisten such soils. They may also be greatly improved by surface mulching, and by the plowing under of green crops.

XXII. CALCIUM, MORTAR, CEMENT, PLASTER.

Symbol, Ca.; Sp. Gr. 1.58; At. Wt. 39.9.

Important Compounds.

Lime, $C_a O$.
Carbonate of Lime, $C_a C O_3$.
Chloride of Calcium, $C_a C_{l\,2}$.
Fluoride of Calcium $C_a F_l$. (see p. 66).
Sulphate of Lime—Gypsum, $C_a S O_4$, $H_2 O$.

Calcium is a yellow metal as hard as gold. It oxidizes in moist air, or in dry air at a red heat, and decomposes water, setting free hydrogen.

Calcium exists abundantly in nature, in the form of limestone. This material has been precipitated from solution in the sea, through the action of various shell-forming animals. Minute shells accumulate upon the floor of the ocean, forming beds of chalk, which afterward solidify into limestone, and, in some instances, crystallize into marble (see p. 66).

If limestone be heated for 24 to 48 hours in a kiln built for the purpose, it yields up its CO_2, and is thus changed into quick-lime, or oxide of calcium.

SLACKING LIME.—When water is added to quick-lime, a powerful re-action occurs. The lime and water enter into chemical union, forming Hydrate of Lime. In this process, the water is solidified, and the arrest of molecular vibration produces great heat. The lime expands, falls into powder, and largely increases in weight, through the absorption and solidification of water. It is said that 56 pounds of lime will thus absorb 18 pounds of water, the whole being converted into a dry, caustic powder.

MORTAR.—If one part of lime be added to four parts of sand, the whole being moistened and worked into a pasty mass, it will soon harden, through the absorption of CO_2 from the air. This enters into chemical union with the lime, forming a calcium carbonate ($C_a CO_3$), and the water is displaced. Hence, the air of a newly-plastered room remains damp for weeks.

Mortar properly prepared, and undisturbed, grows progressively harder for centuries. This is probably owing to the slow union of the lime with the silica of the sand. An exceedingly hard calcium silicate is thus formed. The mortar of buildings erected thousands of years ago, is now, in many cases, harder than the stone which it holds in place.

WATER-LIME, or HYDRAULIC CEMENT, is made of limestone containing from three to ten per cent. of alumina, and some silica and iron oxide. This lime will not slack by the addition of water; it must be ground in mills prepared for the purpose. Water-lime is made into a mortar which will "set" or harden under water. It is therefore used for building the piers of bridges, and all submarine masonry.

PORTLAND CEMENT is made by combining a silicious clay, containing some iron, with carbonate of lime; moulding the mixture into bricks of suitable size, burning these in a kiln, and grinding them into fine powder. By some manufacturers, soda or potash is added before calcining.

These cements harden, probably through the rapid formation of silicates, which are insoluble in water. The various forms of hydraulic cement are rapidly growing in use, and in the variety of their applications. The exterior stucco of houses, the plastering of cisterns, and the calcareous pavements of sidewalks, are universally made with it.

ARTIFICIAL STONE is formed by mixing Portland cement with fine and coarse sand, gypsum, and various coloring materials, into a stiff mortar, pressing this into moulds, and allowing it to dry and harden. This may be made to resemble a variety of sandstones and granites, and is, if properly compounded, almost as durable.

AIR-SLACKED LIME.—If freshly-burned lime be long exposed to moist air, it gradually absorbs water, crumbles, unites with the CO_2 of the air, and becomes an inert mass, unfit to be used in making mortar. It may be restored to the state of quick-lime by again calcining.

To prevent air-slacking, lime should be promptly slacked with water, and then, if not needed for immediate use, it may be covered up in pits, so as to keep it from the air. The moist hydrate of lime may thus be preserved almost indefinitely, and it improves in quality through the final slacking of particles which resist the action of water at first.

CONCRETE.—This material is a sort of mortar made by mixing together water, lime, fine and coarse sand, and gravel. It is used without other additions for building the walls of houses, gradually hardening into an almost indestructible state. It is usually built into a wall by setting two planks at the proper distance apart, filling the space between them with concrete, and then raising them for a new layer, when the concrete has thoroughly "set."

WHITEWASH and CALCIMINE are prepared by stirring lime and salt with water or milk into a liquid mixture. A portion of glue is often added to make the wash permanent.

WHITING is finely pulverized chalk lime.

LIME-WATER is a saturated solution of lime, much used in medicine for correcting acid states of the stomach. It may be precipitated in the form of carbonate of lime, by passing $C O_2$ through the solution.

EXP.—Allow a lump of quick-lime to slack in an excess of water, and pour off the clear solution into a glass vessel. If the breath be blown into this by means of a glass tube or pipe-stem, the liquid soon becomes milky, and finally a white deposit of carbonate of lime forms at the bottom of the vessel.

SULPHATE OF LIME, or GYPSUM, ($C_a\ SO_4,\ H_2O$), is probably formed in nature by the action of sulphuric acid upon beds of chalk or limestone. It is a rather soft, crystalline solid, often resembling white marble. In many instances, the mass is *laminated*, or divisible into thin layers. In this state it is often confounded with mica, (see p. 66) and is called "isinglass." The two are, however, readily distinguishable by the fact that mica resists a high degree of heat which causes gypsum to speedily crumble.

ALABASTER is a species of white, massive gypsum, much used for making caskets and various ornamental articles.

If gypsum be heated it gives up its water of crystallization, and remains in the form of a white powder, called "Plaster of Paris." Unburned gypsum is ground in mills, and "boiled" or heated in iron vessels until the water enclosed in the cells of its crystals is set free. It is now a pasty mass in a state of powerful ebullition. When the water has evaporated, a dry powder remains, which may be mixed with water and moulded into any desired form. It speedily "sets" or hardens through the re-crystallization of the mass, and the formation of a massive hydrate. The water disappears, being built into the cells of the crystals as water of crystallization.

PRACTICAL HINTS.—In preparing mortar, no very specific directions can be given as to the amount of water required. Enough should be added to make the mortar easy to handle with the trowel. One portion of lime to eight of sand will make a very strong and durable concrete. One part of lime and four of sand form the ordinary mortar for plastering and brick-laying. The mortar which is spread over lath always contains a large amount of hair, which is added to bind the mass more firmly together. This addition is omitted from the surface coat, or *hard finish*, which usually contains a large proportion of gypsum.

PLASTER CASTS are made by greasing the surface of any small object, as an apple, and sinking it till half covered in a cup of liquid plaster of Paris. After this has "set," the hardened surface of the plaster may be oiled, and another measure of the liquid plaster poured on. The upper half of the mould may soon be removed, as the oil keeps it from adhering. Then the apple may be taken out, and a perfect mould remains, which may be filled an indefinite number of times with plaster.

In this way casts are taken of coins, statues, and of the whole or a part of the living human body.

XXIII. ROCKS, GEMS, AND ORES.

The earth is a ball of metals, burned over on the surface. All the teachings of geology and astronomy suggest the thought that the earth and sun had a common origin, were formed of identical or similar materials, and are passing through successive stages of development under the working of one general law. The geologist looks back to the time when the earth was a sun-like body,—a cloud of intensely heated metallic gases.

The highest degree of heat does not tend to chemical union; it rather favors dissociation. In this primary stage the elements must have been mingled, but not united into compounds.

In the process of cooling and condensation, the least fusible elements would naturally be the first to pass from a gaseous or liquid to a solid state. The tendency of metals is to blend into alloys; but the heaviest of these alloys would naturally gather at the centre, and the lightest near the surface, of the growing globe. Exploration has only been possible in the earth's crust; but in so far as it extends, it seems to verify the theory. The earth's surface is mainly made up of the oxides and other compounds of the lighter metals and metalloids, Silicon, Carbon, Aluminum, Sodium, Potassium, Magnesium, and Calcium.

QUARTZ.—Silicon oxidized is silica or quartz. Quartz ground up by natural agencies, washed into the bed of the sea, and re-cemented, forms sandstone.

FLINT is a dark, dense silica, mainly formed of fossil sponges.

LIMESTONE.—Calcium burned forms lime. This substance abounds in sea-water; it must have existed in greater abundance in the ancient oceans. It was withdrawn from the water, and precipitated at the bottom in the form of chalk, by small animals called Foraminifera, and by various sorts of mollusks, or "shell-fish." The recent deep-sea soundings show that nearly the entire bottom of the Atlantic is covered by a stratum of white mud of indefinite thickness. This mud consists mainly of the small shells of Foraminifera and similar animals. Under the microscope they appear in many graceful and beautiful forms. These animals live in the sea-water, and at death their shells accumulate on the ocean-floor, forming a soft, chalky deposit. The larger animals, dying, sink down to the same place, and thus the skeletons of fishes and of sea-birds are mingled with the mass. This material gradually hardens into chalk and limestone. All the rocks of this class in existence were thus formed. Each stratum is an ancient ocean-floor. The limestones are the great cemetery of marine life, and the periods of time required to form them must have been vast.

MARBLE is formed by the crystallization of limestone. This rock, saturated with water, and heated through long periods by the earth's internal fires, is gradually changed in texture. The shell-forms disappear, and the whole mass becomes crystalline. If the limestone be free from impurities, the marble is white, but where various mineral substances are mingled with it, colored marbles result.

GYPSUM, also called Alabaster, and Plaster of Paris, is a sulphate of lime, probably formed by the action upon limestone-beds, of water, holding in solution a little sulphuric acid. This substance resembles mica in its physical structure, and is also often erroneously called Isinglass.

CLAY.—The oxide of aluminum is alumina, the principal element of clay. This material was doubtless formed originally by the burning of the metallic aluminum, but it has since then been worked over many times in Nature's laboratory. The modern clay-beds are mostly derived from the decay of aluminous rocks.

GNEISS and **GRANITE.**—We find that all rivers carry down to the sea quantities of sediments, mainly sand and clay. These materials accumulate near sea-shores, forming strata of varying thickness. There is evidence that in times past these materials were saturated with water, and slowly heated under great pressure. These influences caused the mass to become crystalline in structure, and the materials to pass through chemical changes, which resulted in several new minerals, including Mica, Felspar, and Hornblende. These, with crystals of quartz, make up the mass of such rocks. If these changes are not complete, and traces of the old strata remain, the rock is called Gneiss (Nise). If the process has reached its conclusion, the rock is granite.

FELSPAR is mainly a silicate of alumina and potash, often of a reddish tint.

PORPHYRY is felspar containing large crystals of the same material. The word signifies purple; the rock is often of a beautiful purplish tint.

KAOLIN, or porcelain clay, is mainly alumina of decomposed felspar.

MICA, erroneously called isinglass, is often put into stove doors, on account of its power to resist heat. It can be divided into very thin, shining layers. It is a silicate of alumina, potash, and soda.

HORNBLENDE is mainly a silicate of alumina, soda, potash, and iron. It is tough somewhat fibrous mineral, usually dark or black in color.

ASBESTOS is a very fibrous form of hornblende, much used in places where a porous, indestructible, non-conducting substance is needed.

SLATE is a term applied to a variety of sedimentary rock which divides into thin layers, along planes of cleavage. It is highly silicious.

SHALE is similar to slate, but its layers are irregular, and are often fragmental. *Bituminous shale* is saturated with petroleum, or similar hydrocarbons. Shale and slate were formed from ancient mud-beds, or deposits of fine alumina and silica.

LAVA is an impure glass, formed by chemical action in the crust of the earth. It is a silicate of several bases, including soda, potash, lime, and iron. *Scoria* and *pumice* are forms of spongy lava formed of the froth on the surface of the lava stream. *Obsidian* is a solid, translucent glass, usually of a dark color, abundant in volcanic regions.

BASALT is a heavy, ancient eruptive rock, probably formed in a molten state under great pressure. It is often crystallized into columns. *Trachyte* is a similar rock, not usually columnar in form, and having a larger percentage of metallic bases than basalt. These and similar rocks are often found filling immense vertical crevices in the strata, into which they were pushed from below, when fluid or semi-fluid with heat. Sometimes the softer strata on each side have worn away, leaving the basalt standing in the form of a wall. Such a formation is called a *Dyke*.

TALC and **SERPENTINE** are silicates of magnesia. The latter is often of a beautiful green color, fleshed with white. The former is usually of a pale green color.

Building Stones are selected from many of the varieties named. The sandstones and limestones are easily worked. and are usually arranged in strata of convenient thickness for building into walls. Granite is very durable, and takes a high polish. Basalt is worked with difficulty on account of its hardness, and gypsum is too rapidly acted upon by atmospheric agencies to make a durable wall.

Millstones are made of a hard conglomerate, or of a porous sandstone called *Buhrstone*.

Grindstones and whetstones are cut from hard, fine-grained sandstones.

Gems are crystalline forms of various minerals described above. The diamond, a pure crystal of carbon, has been described in Part I.

The Ruby is a crystal of alumina, containing a little silica, and colored with tin and gold. It is very hard and brilliant, and the finest specimens have a greater market value than the diamond.

The Emerald is a silicate of alumina and glucina, but is colored green with chromium.

The Sapphire and **Oriental Amethyst** are also crystals of alumina, with a little silica. The sapphire is colored blue with cobalt, and the amethyst purple with manganese.

The Opal is a splendid crystal of quartz containing much water. It shines with an iridescent luster only second to that of the diamond. It is said that atmospheric conditions cause variations in the brilliancy of this gem.

The American topaz and amethyst are nearly pure quartz, colored as described above. They are greatly inferior to the Asiatic gems in hardness and lustre.

Artificial Gems.—Crystals of alumina remarkable for size, hardness, and brilliancy, are now artificially made in Paris. Common clay is fused by intense heat, and is kept for months in a fluid state, and afterward allowed to cool very slowly. At last the crucible is broken up, and the centre of it is found to be filled with alumina crystals. These may be made of any desired color by fusing with the clay the proper metallic oxides. It is said, however, that rubies and sapphires of the very best color have not yet been produced in this way.

These artificial gems are sawed and turned into the "jewels" of watches, and are also set as ornaments.

Low-Priced Gems.—Various minerals, formerly classed as precious stones, are now so abundant and cheap as almost to have lost their rank among the gems. The following are some of these:—

The Garnet is a crystal of quartz containing silica, alumina, and iron.

Agate and **Chalcedony** are nearly pure quartz, often showing a beautiful banded structure, of various colors. In the agate these layers are concentric, as the stone is formed in cavities, by successive precipitations upon the walls, ending at the center.

The Carnelian resembles the garnet, but has a less definite crystalline structure, and is tinted with duller and paler colors.

Jasper is a red or green flint, susceptible of a high polish. It is colored with iron, copper, and other metallic oxides.

Malachite is a carbonate and silicate of copper. It is a beautiful stone, clouded with tints of blue and green.

Turquoise is a phosphate of alumina. It is a blue stone formerly much used in jewelry.

Pearls are sometimes classed among gems. They are mainly composed of carbonate of lime, and are found in the shells of oysters and other mollusks. It is supposed that they are secreted in order to coat over irritating substances. Thus, if a grain of sand should become fixed in some fold of the delicate tissues of the oyster, the tendency would be to secrete a covering, in order to prevent further irritation. Such is certainly the origin of many of the pearls.

The finest of these gems come from the seas of southern Asia, but they are found in most varieties of fresh-water and marine shells. They are easily stained and discolored, and dissolve freely in sharp acids.

Ore-Beds are usually formed by the action of water, and it is probable that a large part of the material of ores was once dissolved in the sea, whose waters still hold in solution vast amounts of the various metals.

According to this theory, the metals were precipitated from the seawater in combination with sediments forming the rocks. The different strata contain traces of almost all metals.

Heated waters, leaching through the rocks, dissolved silica and such metals as are most soluble in water of that particular temperature. The water containing these substances flowed into open crevices or cavities, where it is cooled, and the metals were precipitated. In the mining regions of the Pacific slope, such processes are still visibly in progress.

The large deposits of ores of the precious metals are generally found so related to dikes of eruptive rocks as to show that the heat accompanying the eruption was the agent principally concerned in dissolving and gathering together the particles of the ore.

It was formerly supposed that ores came up in a molten state from the interior of the earth. This is now known to be a mistake. All ore-beds are superficial, none of them extending very deeply into the earth's crust.

It is probable that vast quantities of metals, as yet unoxidized, remain at the center of the earth.

XXIV. EXPLOSIVES AND PYROTECHNY.

Explosion is sometimes defined as rapid combustion. One of the simplest forms of this process is shown when two parts of hydrogen and one of oxygen are mixed, and flame applied. The two unite, forming vapor of water.

A more complex re-action is witnessed when a combustible substance, like sulphur or carbon, is mixed with saltpetre (K N O_3), or potassic chlorate (K Cl O_3) in a finely pulverized state, and then ignited. The salt gives up its oxygen to the combustible, and the two unite explosively.

Gunpowder is made by mixing 1 part of nitre, 1 of sulphur, and 3 of charcoal with water, into a perfectly homogeneous paste; the proportions given above being not entirely invariable. The paste is dried into a hard cake, after being powerfully pressed between metallic plates. The dried mass is crushed

[illegible] C + H[illegible] –
[illegible]trate

between corrugated rollers, and reduced by a complicated sifting process into several coarser or finer grades. The grains of gunpowder are polished by being for some time turned in a hollow copper cylinder containing powdered graphite or "black lead." In this way, the surface of each grain is covered with a fine metallic-looking coating.

The larger grains are used for blasting, and for heavy cannon; the finer, for small fire-arms.

Re-Ăction.—When gunpowder is ignited, the oxygen of the nitre unites with the sulphur and the charcoal, forming gases which expand to about 1800 times the bulk of the powder.

$$2\,K\,N\,O_3 + S. + 3\,C = K_2\,S + N_2 + 3\,C\,O_2.$$

$C_{18}\,H_{30}\,O_9$

Gun-Cotton is made by soaking cotton-fibres in a mixture of nitric and sulphuric acids. The appearance of the fibres is scarcely changed by the process, but $N\,O_2$ displaces a portion of the H, and the mass is violently explosive, having a rending force many times that of gunpowder. For ordinary uses it is an unsafe substitute for gunpowder, as it ignites at a much lower temperature, and is liable to explode prematurely.

Gun-cotton may, like ordinary cotton or rags, be reduced to paper-pulp, and moulded into the form of pasteboard disks of a size to fit the bore of a gun. These disks are covered with a water-proof varnish, and in this form are a satisfactory substitute for gunpowder.

Nitro-glycerine is prepared by mixing ordinary glycerine with a mixture of nitric and sulphuric acids. A very complex re-action occurs, resulting in the formation of a molecule represented by the formula $C_3\,H_5\,(N\,O_2)_3\,O_3$.

Nitro-glycerine is a yellowish, heavy oil, of a sweetish taste, which may be ignited by an ordinary flame, and will then burn quietly; but a violent jar or shock causes it to explode with terrific violence. It is the agent principally used in blasting rocks. Holes drilled in the rock are filled with it, and a fuse is inserted, filled with slow-burning gunpowder, but having at its lower end a large percussion-cap. This is exploded by the combustion of the powder, and imparts its explosive motion to the nitro-glycerine.

Dynamite or **Giant-Powder** is a substance greatly resembling hard soap in appearance, and is prepared by mixing nitro-glycerine with a sort of fine silicious earth, which consists mainly of the delicate shells of small organisms called Diatoms. Dynamite is more safely portable than nitro-glycerine, though less powerful in proportion to its weight.

Hercules Powder is very similar to dynamite, and is prepared by using carbonate of magnesia in place of silicious earth.

Percussion Caps are filled with mercuric fulminate. This is prepared by dissolving mercury in nitric acid, and then cautiously adding alcohol. The proportions are: 1 part, by weight, of mercury, 12 of nitric acid, and 11 of alcohol of 86 per cent. strength. Copious white fumes are disengaged, and at last the fulminate, as a white powder, settles at the bottom. It is washed and re-dissolved in boiling water, from which it precipitates in silky crystals on cooling. It must be handled with exceeding care, as it explodes by a shock, with destructive force. While moist, it is ground and mixed with about one-half its own weight of potassic nitrate, and this mixture is the coating of percussion caps.

Fire-Crackers are small cylinders of paper containing a gunpowder in which the chlorate of potash supplies the oxygen. They are ignited by a fuse.

Torpedoes are made by wrapping up in a small paper a particle of fulminating mercury with a little coarse sand. It explodes by being thrown against any hard object.

Tableau Fires and **Fireworks** are preparations of slow-burning powder with some agent which will give a bright color to the flame. For in-door purposes, such as the illumination of a theatre-stage, the best preparation is a mixture of equal parts by measure of pulverized chlorate of potash and gum shellac or white sugar, to which may be added a little strontium nitrate to produce a red flame; oxide of copper, to color it green; and dry carbonate of soda to give it a yellow tint.

In making the above mixture, gum shellac, thoroughly pulverized, will be found better than sugar, as its fumes are less unpleasant. For in-door uses, sulphur is inadmissible.

Magnesium Ribbon is, for the production of nearly white light, the best stage illuminant for the use of amateurs, who have not the means for producing the calcium or electric light. The magnesium lamp produces the best effects, but an excellent illumination may be produced by lighting bits of the ribbon, which are held by the aid of a pair of tweezers in front of a suitable reflector.

Ba 2 7 [illegible] green

[illegible]

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INDEX.

PAGE.

Acids, Vegetable 11
Aërated Bread 28
Agate 68
Alabaster 65
Albumen 20
Albuminoids 20
Alcohol 29, 31
Alcohol Beverages 29
Alcohol Varnishes 52
Ale 30
Alkalies 59
Alkaloids, Vegetable 7
Air-slacked Lime 64
Amethyst 68
Anæsthetics 57
Analine 53
Angelica 30
Antiseptics 24
Aphides 60
Arsenic 58
Arsenious Acid 25, 49
Artificial Gems 68
Artificial Stone 64
Asbestos 67

Bacillus 22
Bacteria 22
Bad Breath 50
Baking Powders 28
Balata 52
Baldness 48
Balsams 13
Basalt 67
Bastie Glass 37
Bathing 50
Bay Rum 49
Bed-Bugs 60
Beds 56
Beef 32
Beer 29
Beet Sugar 16
Bismuth 47
Bleaching the Hair 48
Bluing 43
Blue Colors 51
Brandy 31
Bread 26
Bread Making 27
Brown Stout 30
Buhach 60
Building Materials 54
Building Stones 68
Bunsen Burner 35

Calcium, Mortar, Cement, Plaster 63
Calcimine 65
Candles 36
Candy 18
Cane Sugar 16, 62
Canning and Preserving 25
Carbolic Acid 24
Caramel 17
Carbon Monoxide 41
Carmine 47

PAGE.

Carnelian 68
Carpets 55
Carpet Moths 60
Casein 20
Castor Oil 14
Cellars 55
Celluloid 20
Chalcedony 68
Champagne 30
Cheese 35
Chemistry of Plant Growth 61
Chloral Hydrate 57
Chlorine 25
Chloroform 57
Chocolate 10, 47
Cider 31
Cilium 22
Cinchona 9
Citric Acid 11
Clay 67
Cleansing 41
Clover 63
Cochineal Dye 53
Cockroaches 60
Coffee 9, 46
Colors 51
Common Imposition, A 37
Concrete 64
Cooking Utensils 56
Copperas 24
Cork 20
Corn Sugar 62
Cotton 20
Cyanide of Potassium 59

Dentifrice 49
Depilatories 51
Dextrine 15
Dirt 41
Disinfectants 24
Drainage-Pipes 24
Dress and Respiration 41
Drinks 44
Dryers 51
Dyes and Inks 52
Dynamite 70

Eggs 34
Electric Light 37
Emerald 68
Essential Oils 12
Ether 57
Explosives and Pyrotechny 69

Fats and Oils 12
Felspar 67
Ferments 21
Fertilizers 62
Fibrine 20
Filters 45
Fire-Crackers 70
Fire-Test 37
Fireworks 71
Fish 33

PAGE.
Fixed Oils 14
Fixed Oil Varnishes 52
Flannels 43
Flash Test 57
Flesh-Meats and Other Animal Food 32
Fleas 60
Flies 60
Flint 66
Freckles 51
Fruit-Drying 26
Function of Leaves 62

Gallic Acid 12
Garnet 68
Gelatine 20
Gems 29
Gems (Precious Stones) 68
Germination of Seeds 62
Giant Powder 70
Gin 31
Glue 20
Gluten 21
Gneiss 67
Golden Syrup 16
Gophers 61
Graham Flower 26
Grain Weevil, The 60
Granite 67
Granite-Ware 57
Grape Sugar 18
Grass Stains 44
Grease-Eraser 44
Green Paints 51
Gum Arabic 15
Gum Tragacanth 15
Gun Cotton 70
Gunpowder 69
Gutta Percha 16
Gypsum 65, 66

Hair-Dyes 48
Hair Oils 49
Hair-Wash 49
Hellebore 61
Hemp 20
Honey 18
Hercules Powder 70
Hornblende 67
Houses and Furniture 54
Hydraulic Cement 64
Hydrophobia 59

Illuminating Agents 35
Inks 53
Ink-Stains 43
Insect Bites and Stings 59
Insecticides and Destroyers of Vermin 60
Invisible Inks 54
Iodine 43
Irrigation 63

Jaggery 17
Jasper 68

Kaolin 67
Kerosene 36, 43
Kola 47
Koumiss 31

Labarraque's Solution 25
Lager Bier 29
Lamp-Black 51
Lamp Explosions 37
Lard Cheese 35
Laughing Gas 58
Lava 67
Lignin 19
Limestone 66

PAGE.
Lime Water 65
Linseed Oil 14
Location of Houses 54
Luminous Paint 38

Madder 53
Maize 27
Malachite 68
Magnesium Ribbon 71
Malic Acid 12
Manna 18
Maple Sugar 17, 62
Marble 66
Marking Ink 54
Mattresses 56
Methods of Dyeing 52
Mica 67
Mice 61
Micrococcus 22
Mildews 44
Milk 34
Milk Sugar 17
Millstones 68
Moles 48
Mollusca 34
Mordants 52
Morphine 8
Mortar 64
Mosquitoes 61
Muscatel 30
Mutton 33
Mycoderma Aceti 21

Nicotine 7
Night Attire 40
Nitrate of Silver 43
Nitro-Glycerine 70

Oats 27
Obsidian 67
Oleomargarine 35
Opal 68
Opium 8
Ore-Beds 69
Oxalic Acid 11, 59

Paints and Varnishes 51
Paper 19
Papier Mache 20
Paris Green 61
Partition Walls 55
Pastries 29
Pearled Wheat 26
Pearls 69
Percussion Caps 70
Perfumes 13, 49
Persian Insect-Powder 60
Pimples 51
Plaster Casts 65
Poisons and their Antidotes 58
Poison Oak 59
Pork 33
Porphyry 67
Port Wine 30
Portland Cement 64
Prussic Acid 12
Putty 14
Pumice 67
Purple Ink 53

Quartz 66
Quercitron 53
Quinine 9

Ramie 20
Rats 61
Red Ink 54
Resins 13

PAGE.
Respiration, Animal Heat, Vital Force. 38
Rice 27
Ringworm 61
Roasts and Steaks 33
Rocks, Gems and Ores 66
Roots 62
Rosin 13
Rouge 47
Rough Skin 50
Rubber 52
Ruby 68
Rum 31
Rye 27

Saccharomyces Reesii 21
Sago 16
Salicylic Acid 12
Salt-rising 28
Sapphire 68
Scab 60
Scoria 67
Septicaemia 22
Serpentine 67
Serpent-Poisons 59
Sewerage 55
Shade-Trees 56
Shale 67
Silver, How to Cleanse 44
Size 20
Skin-Bleachers 50
Slate 67
Slacking Lime 64
Sleeping-Rooms 40
Snow 63
Snuff 8
Soap 14, 42
Soot 43
Sorghum 17
Soups 32
Spirillum 22
Squirrels 61
Starch, Gum, Sugar, Wood 15
Stains 42
Stenches and Miasms 24
Strychnine 10
Sulpnate of Lime 65
Sulphate of Iron 24
Summer Fallowing 63

PAGE.
Tableau Fires 71
Taenia, or Tape Worm 33
Talc 67
Tannic Acid 12
Tapioca 15
Tar 13
Taro 15
Tartar 49
Tartaric Acid 11
Tea 9, 46
Teeth 49
Terra Alba 18
Theine 9
Tobacco 7
Toilet, The 47
Topaz 68
Torpedoes 71
Torula Cerevisiae 21
Trichina 33
Tubers 62
Turpentine 13
Turquoise 69

Unctuous Oils 14

Varnish 13, 52
Vaseline 49
Veal 33
Vegetable Acids 11
Vegetable Alkaloids 7
Venison 33
Ventilation 40
Vermilion 47
Vibrio 22
Volatile Oil Varnishes 52

Wall Papers 55
Warming of Chambers 41
Warts 48
Water Lime 64
Wells 44
Whale-Oil 36
Whisky 30
White Lead 51
Whitewash 65
Whiting 65
Wine 30

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